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NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) PREPARATORY PROJECT (NPP)

MISSION SYSTEM AND OPERATIONS CONCEPT

(Volume 1)

July 11, 2000

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

INTEGRATED PROGRAM OFFICE
SILVER SPRING, MARYLAND

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1.0 INTRODUCTION

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) is a joint mission being formulated by the National Aeronautics and Space Administration (NASA) and the NPOESS Integrated Program Office (IPO). The NPP mission provides remotely sensed land, ocean, and atmospheric data that serves the meteorological and global climate change communities. The NPP mission is planned for a late 2005 launch.

1.1 PURPOSE

The primary purpose of the NPP Mission System and Operations Concept (Conops) document is to provide a technical description of the planned functions and operations of the NPP System comprised of space and ground assets. The Conops presents a functional model of the System based on high level program guidance and requirements and users needs. From the functional model, defined in a set of data flow diagrams, a series of operational scenarios describe sequences of activities for a selected set of mission events, thereby ensuring all functions are identified and thus captured as mission level requirements.

A secondary purpose of the Conops is to provide an overview of the NPP System and its functions for the more casual reader. Therefore, Sections 1, 2, 3.0, and 4.0 through 4.3.2.1 offer a high level description of the system without delving into the lower level technical details necessary to the engineering team.

1.2 SCOPE

The scope of the Conops includes all functions associated with the NPP System, space and ground, as well as those external entities that directly provide information to, or receive information from, the NPP System. Thus, the Conops encompasses the acquisition of data by the sensors onboard the satellite, transmission to the ground, and processing of the data and making them available to the users. Physical attributes and implementation approaches are intentionally omitted to permit the architectural design activities to take full advantage of potential implementation options.

Because the instruments to fly on NPP are already in the process of being procured, sensor documentation should be referenced for current detailed descriptions and requirements.

1.3 BACKGROUND

The NPP mission is considered a bridge between the Earth Observing System (EOS) and the NPOESS programs. The mission provides continuity of climate data measurements for NASA and risk reduction for the NPOESS IPO. For NASA, NPP is part of the EOS program, providing extended observations for key sustained measurements identified in the EOS Science Plan. For IPO, NPP provides an opportunity to demonstrate and validate new instruments, algorithms, and pre-operational processing capabilities prior to the first NPOESS flight.

The NPP System is being defined, and will be implemented, based on the Initial Implementation Agreement (IIA) on behalf on the two Programs. The IIA identifies the work split responsibilities to either NASA or IPO. This work split is taken into account in the definition of this Conops.

With the NPOESS IPO in place well before the determination to formulate the NPP mission, a number of NPOESS related activities have already been initiated. In part, some of those activities and their deliverables are now planned for the NPP Mission. Key NPOESS instruments are underway, either in implementation or in a competitive down-select mode. To the extent specific information is available, it is functionally reflected within the Conops. For information that remains competition sensitive, general functional descriptions are included.

1.4 DOCUMENT ORGANIZATION

Section 1 of the document provides the introduction to this document. Section 2 provides a high level overview of the NPP System. Section 3 provides the NPP System concept as a series of functions, decomposed to an adequate level of lower level functions sufficient to understand the system capabilities and interfaces. Section 4 provides the NPP System operations concept in the form of operational scenarios for selected sequences or threads described in terms of the System concept. An acronym and abbreviations list is contained in Appendix A. The data dictionary is contained in Volume II.

1.5 APPLICABLE DOCUMENTS

The key documents that apply to the development of this document are:

- EOS Science Plan, January 1999.
- Initial Implementation Agreement Between National Aeronautics and Space Administration (NASA) and the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) for the NPOESS Preparatory Project (NPP), November 1999.
- Advanced Technology Microwave Sounder (ATMS) Initial Implementation Agreement, August 1998.
- NASA Formulation Phase Level 1 Requirements for NPP, 28 March 2000.
- NPP Project Formulation Plan, 429-99-01-01, November 1999.
- Integrated Operational Requirements Document, (IORD), March 1996.
- Visible Infrared Imaging Radiometer Suite (VIIRS) Sensor Requirements Document (SRD) for NPOESS Spacecraft and Sensors, NPOESS Integrated Program Office, Version 2, Revision d, 03 May 2000.
- Cross-Track Infrared Sounder (CrIS) Sensor Specification, ITT Document 8179801, Version 1, 4 May 2000.
- ATMS Performance and Operations Specification, GSFC-S-480-99, August 5, 1999.
- Consultative Committee on Space Data Systems (CCSDS) 701.0-B-2, Advanced Orbiting Systems (AOS), Networks and Data Links: Architectural Specification, Blue Book, Issue 2, June 1998.

2.0 SYSTEM DESCRIPTION

The NPP is a joint partnership between NASA and the NPOESS IPO whose mission is to accomplish the following objectives:

- Demonstrate and validate global environmental imaging and sounding instruments, algorithms and pre-operational ground system in order to provide risk reduction to the first NPOESS flight.

- Provide continuity of the calibrated, validated and geo-located EOS Terra and Aqua systematic global imaging and sounding observations for NASA Earth Science research.

For mission definition and formulation purposes, the NPP System is defined at the highest level in terms of six segments. These segments are used for the purpose of describing the System with the understanding that some functions currently found within one segment may ultimately be implemented in another segment, should it be deemed appropriate. See Figure 2-1, NPP System Overview.

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2.1 SPACE SEGMENT

The Space Segment (SS) consists of the satellite and pre-launch ground support equipment (GSE). The satellite is comprised of the spacecraft and instruments. The instrument complement includes: Visible-Infrared Imager Radiometer Suite (VIIRS), Cross-Track Infrared Sounder (CrIS), and the Advanced Technology Microwave Sounder (ATMS). The possibility of an instrument of opportunity (IOO) is still being evaluated, but preliminary information for an IOO is included.

The NPP is planned for an 833 km polar, sun-synchronous orbit with a 10:30 am descending node, equatorial crossing time. Sensor data are acquired continuously, stored onboard and are subsequently downlinked to polar ground stations for capture, preprocessing, and routing to the processing sites within the United States. Additionally, a continuous, realtime high rate data (HRD) direct broadcast capability is planned for transmitting all instrument, and auxiliary data to users equipped to receive these data.

2.2 COMMAND, CONTROL AND COMMUNICATIONS SEGMENT

The Command, Control and Communications Segment (C3S) provides the NPP satellite operations capabilities, communication routing of mission data and the ground receive stations. The C3S also provides for the overall mission management and coordination of joint program operations needs. Mission Management represents both the operational and scientific communities.

The satellite operations capabilities include the mission planning and scheduling, resource coordination, building, verifying and sending of command loads, realtime attitude determination and maintenance of spacecraft databases. Off-line activities include spacecraft simulation, flight software maintenance, mission trending and analysis, and as necessary, anomaly resolution. The communication routing functions include those activities associated with the planning, scheduling and coordination of network communication links. The polar ground station coordination and intra-segment communication services are also provided.

2.3 INTERFACE DATA PROCESSING SEGMENT

The Interface Data Processing Segment (IDPS) provides for ingest of raw sensor data and telemetry received from the polar ground stations. The artifacts from the communication routing are removed, providing raw data records (RDRs) which are subsequently processed to create Sensor Data Records (SDRs) and Environmental Data Records (EDRs). The RDRs, SDRs, and EDRs are made available to five meteorological Centrals for use in application specific weather related predictions. The four centrals are:

- National Environmental Satellite, Data, and Information Service (NESDIS)
- Air Force Weather Agency/55th Space Weather Squadron,
- Fleet Numerical Meteorology and Oceanography Center (FNMOC), and
- Naval Oceanographic Office (NAVOCEANO).

The data records are provided to the Centrals on a time critical basis (three hours from sensor acquisition), although as a pre-operational demonstration, this timeliness is viewed as a goal rather than an operational requirement. Additionally, the IDPS also provides an operational level of calibration and validation of the algorithms and the performance of the payload sensors. The RDRs, SDRs, and EDRs are forwarded to the Archive and Distribution Segment (ADS) for archiving and broader user access.

2.4 SCIENCE DATA SEGMENT

The Science Data Segment (SDS) ingests the RDRs from the IDPS. The SDS validates format and volume/size of the RDRs, ensuring all data are received. The SDS processes the RDRs, creating a Level 1B product. The Level 1B is comparable to the IDPS SDR product, but is generated using NASA sponsored science algorithms. The RDRs are stored in the SDS for the life of the mission, permitting reprocessing when improved science algorithms are made available from the science community.

The Level 1B data are provided to a small, competitively selected science user group who are responsible for generating identified Level 2/3 science products. These products are unique to the science research community or represent a significant science benefit beyond the IDPS EDRs. To the extent feasible, the EDRs are planned to serve the global change community, in addition to the operational weather community, minimizing the extent and scope of the SDS. It is intended that the SDS algorithms be coordinated with the Centrals and ultimately be incorporated as part of their nominal routine processing. The SDS also performs science calibration and validation and coordinates with the IDPS on results, and as necessary, calibration file changes. All Level 1B and Level 2/3 products are provided to the ADS, thereby providing wide user access to all science products.

2.5 ARCHIVE AND DISTRIBUTION SEGMENT

The ADS receives the RDRs, SDRs, and EDRs from the IDPS and the Level 1B and Level 2/3 products from the SDS. All of these data are archived, as are the associated metadata upon which users may search and order data. Upon request, data products are distributed to users who are billed for the cost of fulfilling the request.

2.6 LAUNCH SERVICES SEGMENT

The Launch Service Segment (LSS) provides those assets and services associated with the launch vehicle (LV) and the payload integration. Included, along with the launch vehicle, are all ground support equipment, property, and facilities to integrate the spacecraft to the LV, verify their integration, and conduct pre-launch testing with the ground system.

2.7 EXTERNAL INTERFACES

The external interfaces identify those entities that are outside of the domain of the NPP System, but are required to convey the full mission functions and objectives. The external interfaces provide information to the NPP System and/or receive information from the NPP System. The context level diagram shows the NPP Mission System contained within a single bubble and all external entities as boxes.

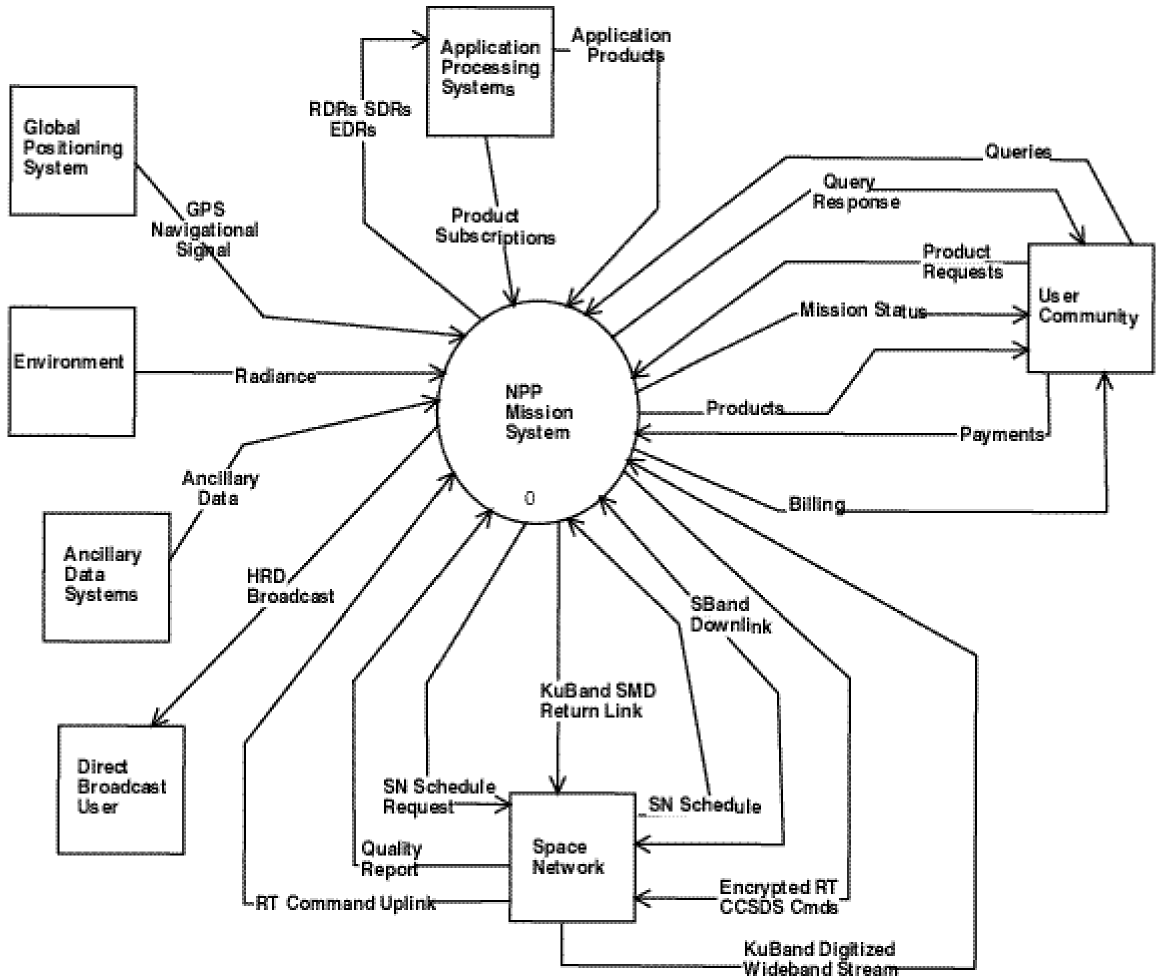

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Figure 2-2. NPP Context Diagram

2.7.1 User Communities

The NPP, as a joint mission, is serving multiple objectives and thus user communities. The operational user community expects to receive the NPP data as a pre-operational demonstration for NPOESS. The climate users, or global change community, view these data as a continuity to the systematic measurements initiated by the EOS Terra and Aqua missions for purposes of assessing long term global change.

2.7.1.1 Operational

The operational or US weather service community is expected to use the NPP data in a pre-operational demonstration prior to the NPOESS missions. NPP, flying a subset of the NPOESS payload complement, provides an opportunity for the Centrals to evaluate the instruments and algorithms and begin to incorporate these data as part of their nominal operational processing and prediction.

2.7.1.2 Climate

The climate community is planning to use the NPP data in conjunction with those data obtained from previous EOS missions, affording an extended dataset with which to evaluate and report global change. The climate community is expected to utilize products from both the IDPS and the SDS in order to perform their science analyses.

2.7.2 Environment

The environment is the space environment from which radiances are detected by the payload instruments. This may be considered the beginning of the flow of telemetry data, those that are captured and manipulated throughout the NPP System until available to the user.

2.7.3 Global Positioning System

The Global Positioning System (GPS) is a constellation of satellites from which space-coordinate navigational information is received. Based on input from multiple GPS satellites, the NPP satellite can determine position, time, and velocity.

2.7.4 Networks

The networks are those space to ground communication networks outside of the NPP System that are used to transmit command information to, and receive telemetry from the NPP satellite.

2.7.4.1 Deleted CH-01

2.7.4.2 Space Network

The NASA Space Network (SN) is providing space-to-ground return link communication. The SN is also planned for use during spacecraft calibration and orbit adjust maneuvers during which time the satellite is out of sight of the polar ground stations. CH-02

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2.7.6 Direct Broadcast Users

The Direct Broadcast Users are considered an external entity, capable of receiving realtime direct broadcast data. All realtime instrument and auxiliary data (including spacecraft, calibration data, etc.) are contained in the HRD broadcast stream.

2.7.7 Ancillary Data Systems

The ancillary data systems represent suppliers of any non-NPP data used as input for the NPP data processing. This may include climatologic, model, other instrument data, etc. that are used to produce data products in IDPS and SDS.

2.7.8 Application Processing Systems

The application processing systems are any external systems that receive the NPP RDRs, SDRs, EDRs for the intended purpose of performing additional, application specific processing. These may be institutional systems or newly defined systems at the Centrals that are planning to use NPP data for generating products to serve specific users needs.

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3.0 SYSTEM CONCEPT

The NPP system concept is described in the framework of six segments as shown in Figure 3-1. The SS, LSS, C3S, and IDPS for NPP are similar to the segments used to describe the NPOESS. The SDS and ADS contain functionality required to complete the NPP system concept. While the functions described in the SDS and ADS may ultimately be required for NPOESS as well as NPP, they are currently outside the scope of responsibility of the NPOESS IPO. The allocation of functions to specific segments is based on experience gained from developing similar systems and helps to describe the NPP system concept. However, this allocation is not meant to constrain the NPP system architecture to be defined later in the lifecycle. Therefore, while the objective of the Conops is to capture all necessary functionality of the NPP System, some functions may ultimately be allocated to different segments at a later time.

Each segment is functionally described by a set of Data Flow Diagrams (DFDs) and textual descriptions. The DFDs are arranged in a hierarchical format to show a structured, top-down view of the end-to-end system. The SS description is unique because of the allocation of the segment into physical elements (i.e. spacecraft, instruments, and ground support equipment). This approach helps to describe the SS based on the accelerated life cycle of the instruments compared to the rest of the NPP system.

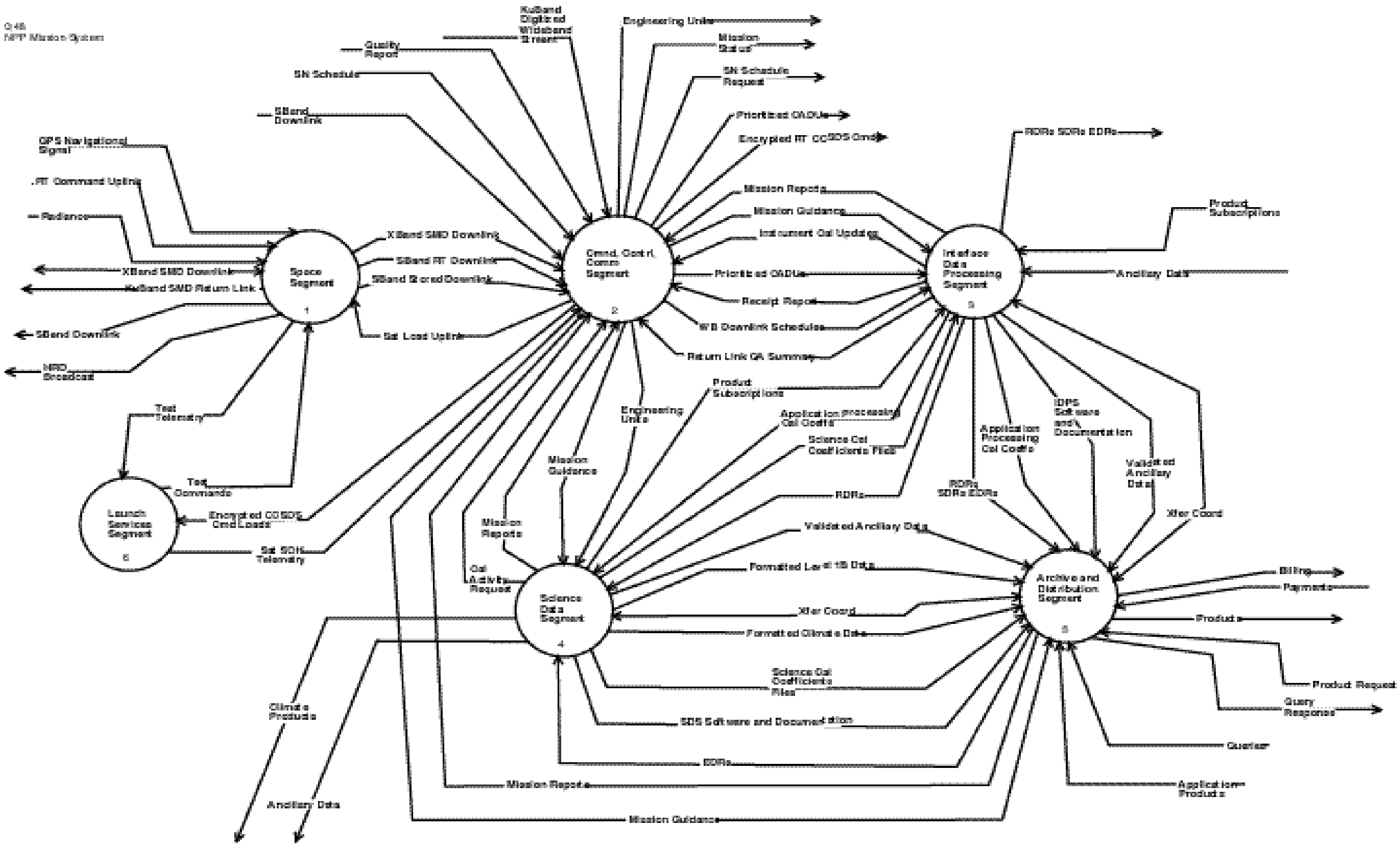

Figure 3-1. NPP Mission System DFD

CH-02

Each function, or bubble, is labeled with two identifiers. The first identifier is the function name that summarizes the process being performed. The second identifier is a numerical identifier that is used to reference the location of the function within the hierarchical structure of the system concept. The numerical identifier is not intended to imply a specific sequence of events. Intra- and inter-data exchanges are represented by arrows with data flow names.

3.1 SPACE SEGMENT

As shown in Figure 3-2, the NPP satellite is comprised of the Spacecraft, VIIRS, CrIS, ATMS and potentially an IOO. The NPP satellite and associated GSE make up the Space Segment.

Planned for a late 2005 launch and a 5 year mission life, the NPP satellite is placed in an 824 km polar, sun-synchronous orbit, with an equatorial crossing time of 10:30am (+/- 10 minutes) for the descending node. The ground track repeat is less than 20 days and managed to within +/- 20 km. Pixel geo-location knowledge for surface products is planned to be 200m (3 sigma) at nadir after post-processing.

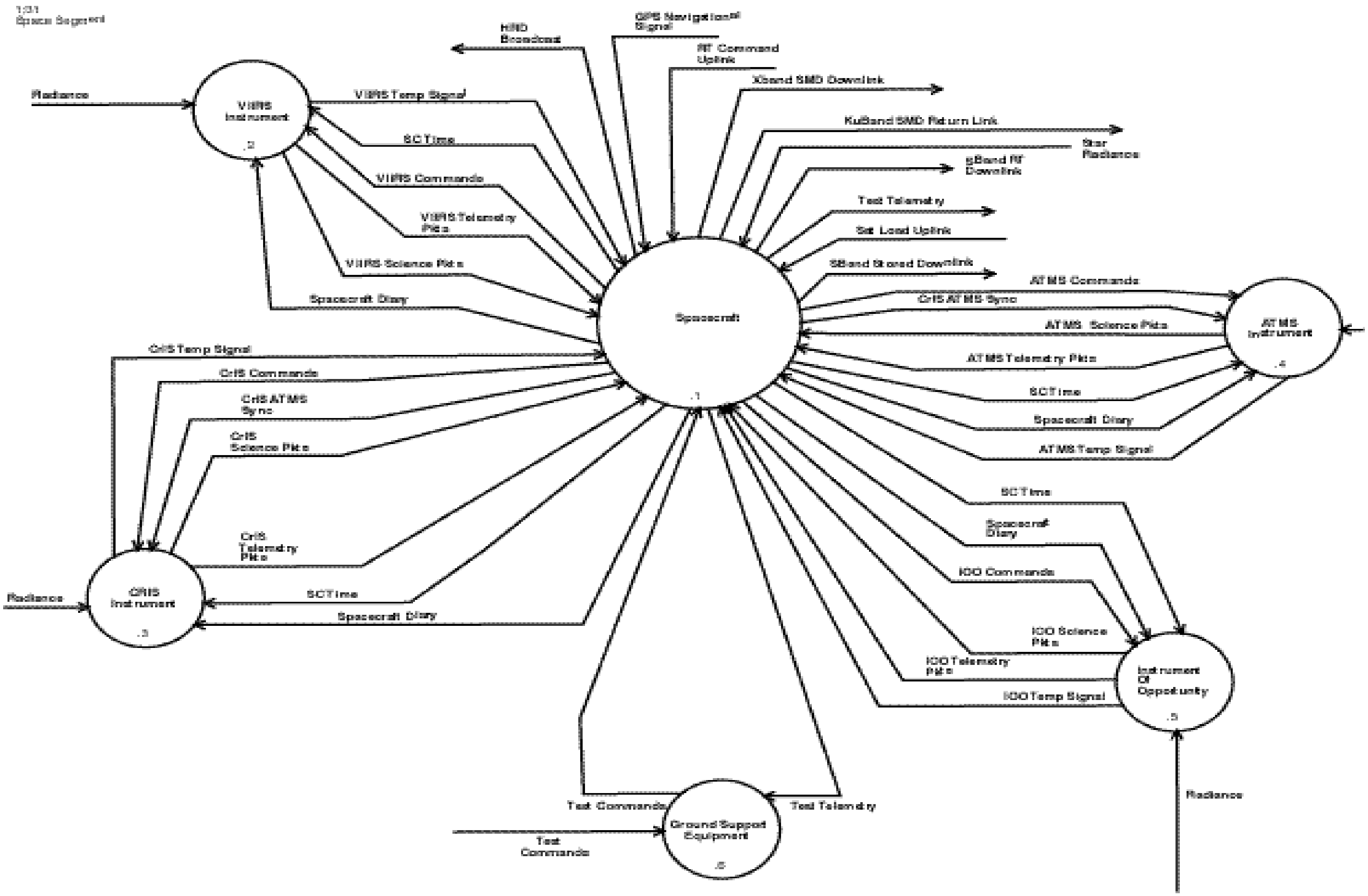

Figure 3-2. Space Segment DFD

CH-02

3.1.1 Spacecraft

The Spacecraft Provides Narrowband and Wideband communications interfaces to C3S and/or external functions, Controls The Satellite to provide the instrument payload with a stable platform, Manages Power and Thermal Functions to maintain a sound spacecraft condition, and Provides Fail Safe Protection in the event of anomalous conditions. Figure 3-3 details the dataflow.

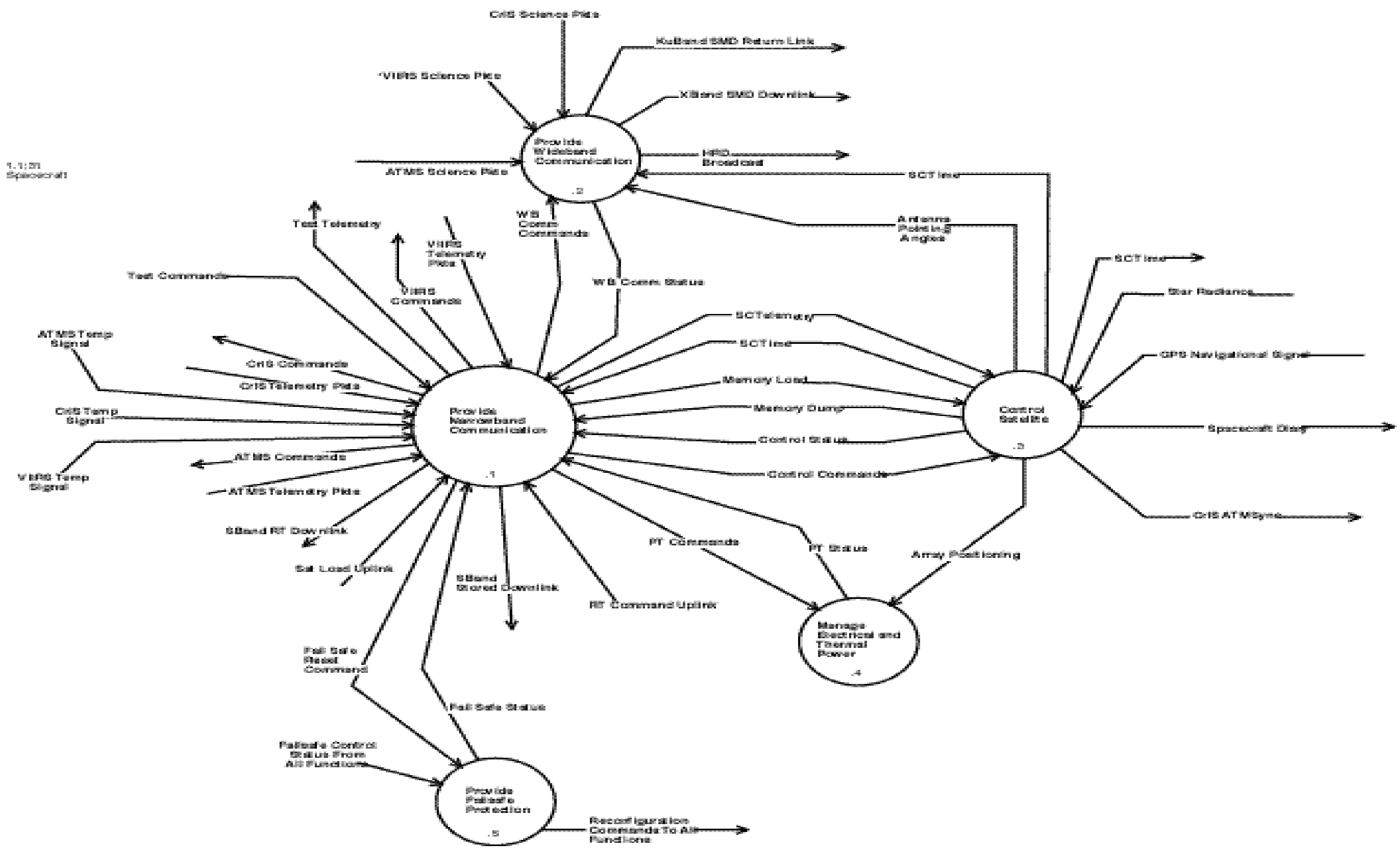

Figure 3-3. Spacecraft DFD

CH-02

3.1.1.1 Provide Narrowband Communication

The Provide Narrowband Communication function (Figure 3-4) within the Spacecraft is further decomposed into eight lower level functions. They are:

- Receive Narrowband Uplink
- Authenticate Commands
- Validate and Process Commands
- Store and Forward Commands
- Generate Telemetry
- Store and Forward Telemetry
- Downlink Narrowband
- Accommodate Spacecraft Software Updates.

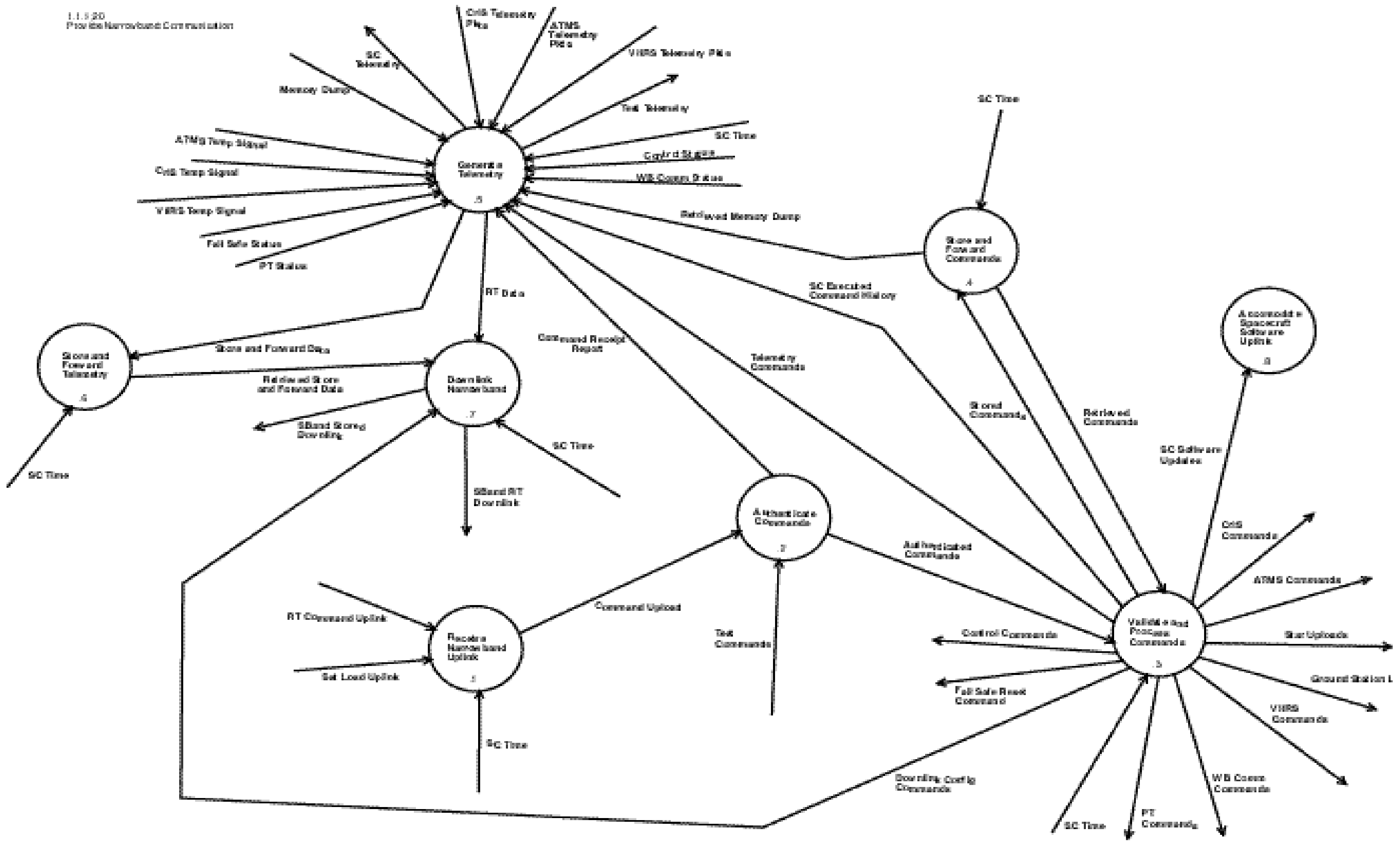

Figure 3-4. Provide Narrowband Communications DFD

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3.1.1.1.1 Receive Narrowband Uplink

The Receive Narrowband Uplink function receives and demodulates the Real Time (RT) Command Uplink and SC Load Uplink data. The RT Command Uplink and SC Load Uplink data are de-commutated and the extracted Command Upload data are routed to the Authenticate Commands function.

3.1.1.1.2 Authenticate Commands

The Authenticate Commands function receives the Command Upload data from the Receive Narrowband Uplink function and verifies the authenticity of the received command. A copy of the command data as it was received is output to the Generate Telemetry function as the Command Echo data. Authenticated Commands are output to the Validate and Process Commands function.

3.1.1.1.3 Validate and Process Commands

The Validate and Process Commands function receives Authenticated Commands, routes Stored Commands to memory storage, Retrieved Commands, and Test Commands and routes processed Control Commands, WB Comm Commands, NB Comm Commands, VIIRS Commands, ATMS Commands, CrIS Commands, Power and Thermal (PT) Commands, and Failsafe Commands to satellite functions. The Validate and Process Commands function sends NB downlink Configuration Commands to the Downlink Narrowband function to configure downlink hardware and Telemetry Commands to the Generate Telemetry function to configure telemetry output modes. The Validate and Process Commands function extracts memory load data and sends Spacecraft Software Updates to the Accommodate Software Uplink function and Star Uploads and Ground Station Locations data to the Control Satellite Function.

3.1.1.1.4 Store and Forward Commands

The Store and Forward Commands function receives Stored Commands from the Validate and Process Command function. The function utilizes SC Time to recover Retrieved Commands for re-entry to the Validate and Process Commands function.

3.1.1.1.5 Generate Telemetry

The Generate Telemetry function commutates input data flows and outputs composite frame formatted output data flows according to CCSDS AOS Grade 2 Service recommendation. The input data flows utilized to generate the commutated output are the Command Echo, the SC Executed Command History, Retrieved Memory Dump, Memory Dump, SC Time, Telemetry Pkts from All S/C Functions, VIIRS Telemetry Packets, CrIS Telemetry Packets, and ATMS telemetry Packets. The output data flows include RT Data, Store and Forward Data, SC Telemetry, and Test Telemetry to Ground Support Equipment (GSE).

3.1.1.1.6 Store and Forward Telemetry

The Store and Forward Telemetry function utilizes the SC Time data to record and hold SC Telemetry provided by the Generate Telemetry function, and to output Retrieved SC Telemetry to the Downlink NB function.

3.1.1.1.7 Downlink Narrowband

The Downlink Narrowband function transmits narrowband telemetry from the spacecraft. The downlink function utilizes the RT Data to modulate the real time narrowband transmitter for immediate output of the SBand RT Downlink data. The Downlink Narrowband function utilizes the SC Time data flow to bring in Retrieved Store and Forward Data to modulate the SBand Stored Downlink at predicted station contact times.

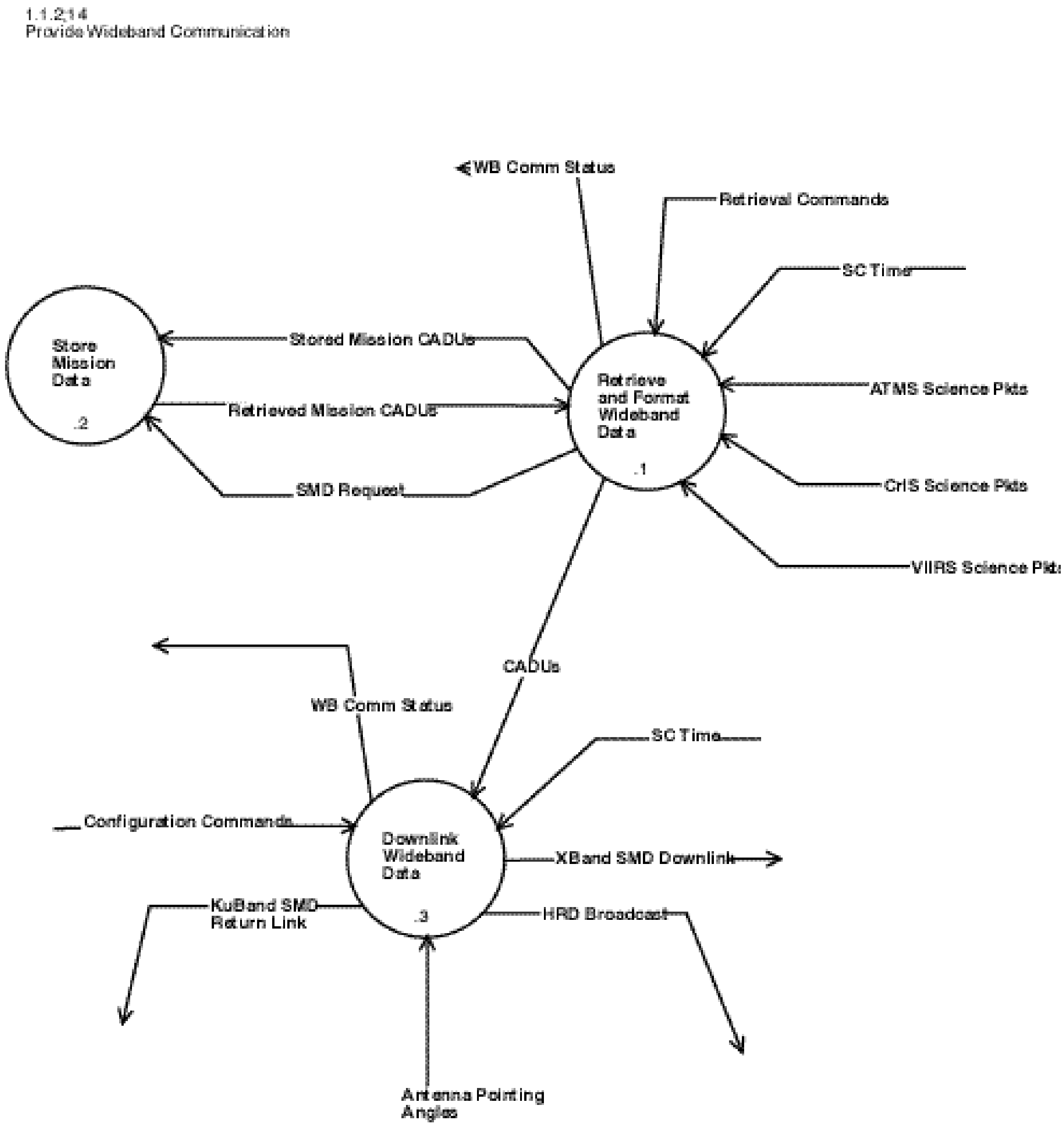
3.1.1.1.8 Accommodate Spacecraft Software Updates

The Accommodate Spacecraft Software Updates function receives Spacecraft Software Updates from the Validate and Process Commands function. The Accommodate Spacecraft Software Updates function validates the Spacecraft Software Updates, loads and executes the updates according to the command and verifies the Spacecraft Software Updates. The Generate Telemetry function reports the Spacecraft Software Updates verification through the spacecraft telemetry.

3.1.1.2 Provide Wideband Communication

The Provide Wideband Communication function (Figure 3-5) within the Spacecraft is further decomposed into 3 lower level functions. They are:

- Retrieve and Format Wideband Data
- Store Mission Data
- Downlink Wideband Data.



CH-02

Figure 3-5. Provide Wide Band Communications DFD

3.1.1.2.1 Retrieve and Format Wideband Data

The Retrieve and Format Wideband Data function receives VIIRS Science Pkts, CrIS Science Pkts, and ATMS Science Pkts, formats the Stored Mission Data according to the CCSDS AOS Grade 2 Service recommendation for Channel Access Data Units (CADUs), and utilizes the SC Time and Retrieval Commands to store and retrieve stored mission CADUs. The CADUs are output to the Downlink Wideband Data function. WB Comm Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.2.2 Store Mission Data

The Store Mission Data function receives CADUs from the Retrieve and Format Wideband Data and, stores them, and retrieves them for output to the Downlink Wideband Data function.

3.1.1.2.3 Downlink Wideband Data

The Downlink Wideband Data function receives CADUs from the Retrieve and Format Wideband Data function and utilizes SC Time to modulate and transmit Stored Mission Data (SMD) Downlink data at predicted ground station contact times. Antenna Pointing Angles provided by the Control Satellite function steer the stored mission downlink antenna to accomplish successful ground station downlink. CADUs are also used by the function to modulate and transmit Wideband Broadcast data in realtime. Configuration Commands are used to control downlink data content. WB Comm Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.3 Control Satellite

The Control Satellite function (Figure 3-6) within the Spacecraft is further decomposed into six lower level functions. They are:

- Calculate Ephemeris and Time
- Determine Pointing Adjustments
- Store Navigation Information
- Determine and Control Attitude
- Generate Spacecraft Diary
- Manage Spacecraft Clock.

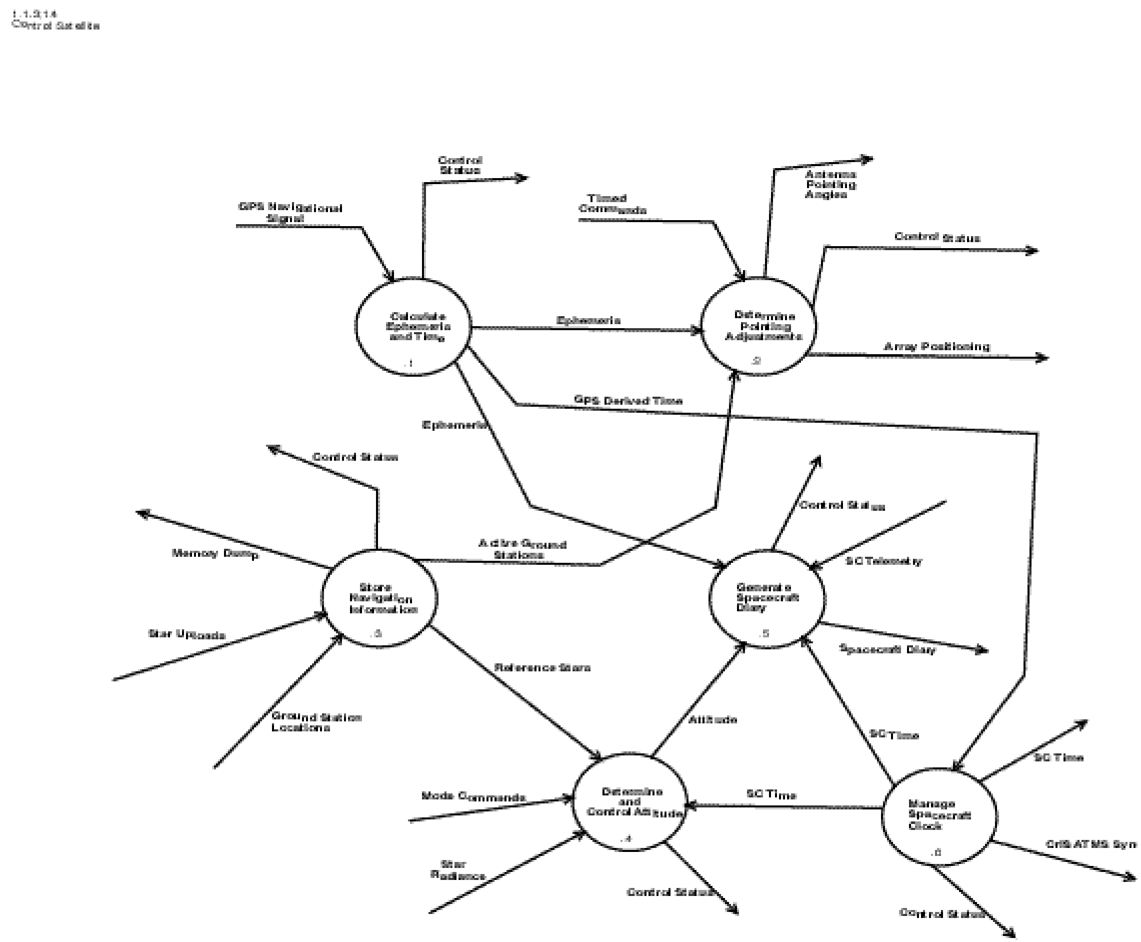


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Figure 3-6. Control Satellite DFD

3.1.1.3.1 Calculate Ephemeris and Time

The Calculate Ephemeris and Time function receives the GPS Navigational Signal and determines the NPP satellite position and velocity. The Ephemeris data are provided to the Determine Pointing Adjustment and Generate Spacecraft Diary functions. Based on the GPS Navigational Signal the GPS Derived Time for the NPP satellite is determined and sent to the Manage Spacecraft Clock. Control Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.3.2 Determine Pointing Adjustments

The Determine Pointing Adjustments function receives the Timed Commands from the Validate and Process Commands function.

The Determine Pointing Adjustments function receives the Ephemeris from the Calculate Ephemeris and Time function and the Active Ground Stations from the Stored Navigation Information function and determines necessary antenna and array pointing adjustments. The Antenna Pointing Angles are sent to the Provide Wideband Communications function and the Array Positioning is sent to the Manage Electrical and Thermal Power function. The Control Status is provided to the Generate Telemetry function.

3.1.1.3.3 Store Navigation Information

The Store Navigation Information function receives Star Uploads and Ground Station Locations from the Provide Narrow Band Communications function and stores them in memory for use. Reference Stars are output to the Determine Control Attitude function. Memory Dump data is generated by the function for output to the Generate Telemetry function. Control Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.3.4 Determine and Control Attitude

The Determine and Control Attitude function retrieves Reference Stars from memory storage and uses star tracker output data, earth and sun sensor data to determine the spacecraft attitude. Mode Commands and Attitude data are used to generate control signals for RWAs, Mag Torquers, and other attitude control devices. Attitude data are output to the Generate Spacecraft Diary function. Control Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.3.5 Generate Spacecraft Diary

The Generate Spacecraft Diary function receives Ephemeris data, Attitude data, SC Time, and SC Telemetry from various spacecraft functions and generates Spacecraft Diary data. The Spacecraft Diary data are output to the VIIRS, CrIS, and ATMS for inclusion in instrument telemetry. Control Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.3.6 Manage Spacecraft Clock

The Manage Spacecraft Clock function receives the GPS Derived Time from the Calculate Ephemeris and Time function. SC Time is set and maintained by the function. SC Time is routed to all other spacecraft functions. Control Status is assembled from sensor and status monitors and output to the Generate Telemetry function. The CrIS ATMS Sync, for instrument synchronization, is sent to the CrIS Instrument and ATMS Instrument functions.

3.1.1.4 Manage Electrical and Thermal Power

Manage Electrical Power and Thermal Function within the Spacecraft involves the solar arrays, the batteries, and the thermal control systems. This function maintains thermal control through a combination of active and passive techniques. It uses the Array Positioning data from the Control Satellite function to position the solar arrays in relation to the sun. The solar array output is passed to the electrical distribution network that supplies 28 VDC power to all functions, utilizing batteries when necessary. This function also charges the batteries and dissipates excess power through the solar array.

3.1.1.5 Provide Failsafe Protection

The Provide Failsafe Protection function within the Spacecraft is further decomposed into three lower level functions (Figure 3-7). They are:

- Monitor State of Health Status
- Assess State of the Satellite
- Take Corrective Action.

Figure 3-7. Provide Failsafe Protection DFD

3.1.1.5.1 Monitor State of Health Status

The Monitor State of Health Status function receives Failsafe Control Status data and instrument data from all lower level functions within the Control Satellite and the Manage Electrical and Thermal Power function. The status data are evaluated for out of limit conditions. Out of Limits data are sent to the Assess State of the Satellite function. Fail Safe Status is assembled from sensor and status monitors and output to the Generate Telemetry function. Failsafe status information include data on out-of-bounds states such as S/C attitude, S/C temperatures, and power condition.

3.1.1.5.2 Assess State of the Satellite

The Assess State of the Satellite function receives Out of Limits data from the Monitor Status function and assesses the need for corrective action. Change State Decision data are sent to the Take Corrective Action function for use in reconfiguring the satellite state. Fail Safe Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.1.5.3 Take Corrective Action

The Take Corrective Action function receives the Change State Decision data and issues Reconfiguration Commands to satellite functions to rectify out of limits conditions. Fail Safe Status is assembled from sensor and status monitors and output to the Generate Telemetry function.

3.1.2 VIIRS Instrument

The purpose of the VIIRS is to collect visible and infrared radiometric data. Global observations of land, ocean, and atmospheric parameters are taken at a high (approximately daily) temporal resolution. These data are processed and delivered to the users in the form of RDRs, SDRs, and EDRs. VIIRS satisfies 28 EDRs, as described in the VIIRS Sensor Requirements Document.

The VIIRS consists of one or more instruments designed to measure scene radiance in spectral bands within the visible to thermal infrared range (from 0.3 to 14 microns, approximately) and has a swath of 3000 km. The VIIRS dataflow is described in Figure 3-8.

Figure 3-8. VIIRS Instrument DFD

3.1.2.1 Control Sensor Functional Mode

The VIIRS will implement the following operational modes as a minimum:

- OFF
- OUTGASSING
- ACTIVATION
- EARLY ORBIT CHECKOUT
- OPERATIONAL (DAYTIME, NIGHTTIME, AND TERMINATOR SUBMODES)

- DIAGNOSTIC
- SAFE HOLD
- SURVIVAL
- One or more CALIBRATION modes, if needed

- OFF Mode

In the sensor OFF mode, no power is supplied to the sensor, with the possible exception of power to survival heaters and critical health and safety monitoring components. The VIIRS is in the OFF mode during launch phase and orbit acquisition. To the maximum extent feasible, the VIIRS is designed to allow the spacecraft to monitor its health and safety while in the OFF mode. For example, critical, instrument temperatures may be monitored by the spacecraft. Thermostatically controlled survival heaters connected to a separate power bus is provided, as necessary, to protect the instrument in this mode.

- OUTGASSING Mode

The VIIRS is in the OUTGASSING mode during the early days of the mission, during which time the instruments are non-operating or in partial operation. This mode may also be exercised at any time during the mission when decontamination is required. Instrument subassemblies or components are powered on in this mode only as necessary to facilitate outgassing, not to provide valid Earth scene or calibration data. In this mode, the optics, cooler, and other critical components are protected from contamination. This mode includes the capability to warm up any cold critical elements to allow any contamination build-up to outgas.

- ACTIVATION Mode

In the ACTIVATION mode the VIIRS turns on and instrument components are warming up, or cooling down, to their operating temperatures. This mode terminates when all instrument temperatures, biases, and currents have stabilized within specified operational limits. This mode also includes any deployments and opening of covers or shutters.

- EARLY ORBIT CHECKOUT Mode

The EARLY ORBIT CHECKOUT mode is a test mode in which the VIIRS collects data to verify that performance complies with design and meets requirements. This mode may be regarded as a sub-mode of the common sensor DIAGNOSTIC Mode. EDR swath width requirements do not apply in the EARLY ORBIT CHECKOUT mode. The data rate may be maintained within requirements in this mode by limiting the portion of the swath or number of bands for which data are transmitted, or by other means consistent with providing maximum flexibility and utility for performing diagnostics. To support this mode and for anomaly resolution, VIIRS has the capability to selectively disable any on-orbit processing operation that combines or compresses raw data in any manner. Examples of such processing operations are: spatial aggregation of pixel samples; temporal aggregation of pixel samples; averaging of pixel data acquired while viewing calibration sources; averaging of calibration instrumentation data such as source temperature measurements; and data compression.

- OPERATIONAL Mode

In the OPERATIONAL mode the VIIRS is in its full functional configuration. In this mode, Earth scene radiance, calibration, and housekeeping data are acquired. The OPERATIONAL mode is expected to have up to three sub-modes:

-- DAYTIME Mode: Normal daytime operating mode, observing in all bands including the daytime/nighttime visible bands.

-- NIGHTTIME Mode: Normal nighttime operating mode, observing in the daytime/nighttime visible bands and in the emission-dominated infrared bands. In this mode, the reflection-dominated bands, such as the ocean color bands, could be turned off.

-- TERMINATOR Mode: A combined operating mode where the scene contains both day and night information.

- DIAGNOSTIC Mode

The sensor DIAGNOSTIC mode supports housekeeping and software updates. The DIAGNOSTIC mode shall support trouble shooting.

- CALIBRATION Mode(s)

In the CALIBRATION mode(s), the VIIRS views a calibration source and acquires calibration data only. Collection of Earth scene radiance data is suspended in this mode. In this mode, the functional configuration and/or operation of a VIIRS instrument is modified relative to the operational mode configuration and/or operation.

- SURVIVAL Mode

The survival mode is an emergency off mode. The VIIRS is commanded into this mode in the event of a spacecraft emergency. The intent is that all instruments on the spacecraft will be reactivated upon spacecraft recovery. Reactivation requires ground intervention. Thermostatically controlled survival heaters connected to a separate power bus shall be provided, as necessary, to protect the instrument in this mode.

- SAFE HOLD Mode

In the SAFE HOLD mode, health and status data are collected and transmitted. Mission and calibration data are not collected. The sensor accepts a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event. The spacecraft C&DH will issue power conservation re-configuration commands to the sensors via the data bus that will place the sensor in a safe configuration. The return to the OPERATIONAL mode shall require ground intervention. In this mode, most components shall be turned off, with survival heaters activated.

3.1.2.2 Scan Field of Regard

Earth Scene Radiance and Calibration Source(s) Radiances enter through the instrument(s) optics, are converted into data and transferred as Combined Radiance for packetization.

3.1.2.3 Measure VIIRS Health Status

VIIRS acquires sensor health and status telemetry data, which includes all housekeeping data required for sensor status and health monitoring. Sensor Health Status Data telemetry includes:

- Sensor mode and configuration

- Sensor temperatures
- Sensor power supply current and voltage
- Relay status, scan mirror rotation (if applicable), and other rotating mechanism rates
- Other telemetry data required to support sensor performance evaluation

Health Status Data is packetized and communicated to the spacecraft. Health Sensor Thermal Data utilized by the Control Sensor Functional Mode.

3.1.2.4 Assemble VIIRS Packets

VIIRS generates HRD/SMD data packets containing scene radiance, calibration, monitoring, health, and status data. HRD/SMD includes all data with the exception of Near Constant Contrast visible data. HRD may use lossless compression to lower orbital average data rate.

3.1.2.5 Communicate With Spacecraft

The VIIRS processing and control electronics communicates with the spacecraft across a command and telemetry data bus. The spacecraft to VIIRS transfer consists of: VIIRS Commands, memory loads, time Command & Control Data, Time Code Data, Ancillary Data (if required), and Satellite Ephemeris Data are utilized to determine Control Sensor Functional Mode.

3.1.2.6 Measure VIIRS Temp

The Measure VIIRS Temp function passively measures the VIIRS instrument temperatures during all modes, even while the instrument is in the OFF mode. The VIIRS Temp signal is sent to the spacecraft Generate Telemetry function.

3.1.2.7 Accommodate New Software Uplink

The Accommodate New Software Uplink function processes VIIRS Software Uplinks received as instrument commands from the Spacecraft Validate and Process Commands function. The resulting new VIIRS Software Executable is then provided to the Control VIIRS Operation function.

3.1.3 CrIS Instrument

The purpose of the CrIS instrument is to collect infrared radiometric data for atmospheric parameters. In conjunction with the ATMS instrument, CrIS collects global observations of temperature and moisture profiles on a daily basis. The atmospheric radiances are collected in the spectral bands within the infrared range of 3.5-16 microns and CrIS has a swath of 2300 km. The CrIS DFD is described in Figure 3-9.

Figure 3-9. CrIS Instrument DFD

3.1.3.1 Control CrIS Operation

The CrIS processing and control electronics module uses the measured Health Status Data input from the sensor and the, CrIS ATMS Sync, Time Code, and Commands inputs from the spacecraft to Control Sensor Operation, which encompasses all command and control functions for the CrIS sensor, including commanding sensor modes. The CrIS sensor modes and descriptions are listed:

- OFF Mode

The OFF mode describes the state of the sensor when primary and survival heater power is removed. This mode is usually applied during ground testing and launch. In the sensor OFF mode, no power shall be supplied to the sensor. Transition into this mode shall be capable from any functional mode upon issuing a serial command sequence for power down. Survival heater power shall not be provided.

- OPERATIONAL Modes

The OPERATIONAL mode is comprised of four sensor modes:
POWER-ON, MISSION, SENSOR SAFE, and OUTGAS.

-- POWER-ON Mode

The power on mode is defined as an intermediate state of the sensor OPERATIONAL mode towards attaining full functionality. Upon receipt of a power-on pulse command, the sensor transitions into the POWER-ON mode from the OFF mode. Sensor primary power is applied and the data bus is enabled.

-- MISSION Mode

The sensor attains its fully functional configuration within the MISSION Mode. This includes:

- Thermally stable within operational limits
- Synchronization between each module and between the sensor and ATMS
- Science data shall be collected
- Autonomous fault detection capability is provided
- Science, health, and status data shall be transmitted during this mode

-- SENSOR SAFE Mode

The instrument transitions to the SENSOR SAFE mode upon detection of a fault requiring ground intervention. No science data is collected, and transition out of this mode shall require ground intervention.

-- OUTGAS Mode

The OUTGAS mode provides the function of purging contaminants from the sensor. During this mode, power is provided to the radiant cooler outgas heaters and sensor control heaters. No science data is collected. The outgas cycle is completed within a duration of 21 days, and upon completion of the outgas cycle, the sensor transitions autonomously to POWER-ON mode.

- DIAGNOSTIC Mode

The sensor DIAGNOSTIC mode supports housekeeping, software updates, and trouble shooting. Transition to this mode is limited to all functional modes with the exception of the OUTGAS mode.

- SAFE HOLD Mode

The SAFE HOLD mode is enabled in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. The sensor, therefore, plays no part in the transition into this mode. The SAFE HOLD mode is a power conservation mode. The return to the OPERATIONAL modes requires ground intervention. In this mode sensor primary power shall be turned off, with survival heaters activated.

The CrIS ATMS Sync is used to synchronize the cross-track scanning of the CrIS and ATMS instruments.

3.1.3.2 Generate Onboard Calibration Radiance

This function produces a Blackbody Radiance measurement through the use of an internal blackbody calibration source which is an input to the Scan Field of Regard function. The Blackbody Radiance measurement produced is used to generate calibration data packets, an input required to Process Data Records.

3.1.3.3 Scan Field of Regard

The Scan Field of Regard function consists of a cross-track scanning mirror/scene selection module to select and reflect the three potential inputs (Blackbody Radiance, Earth Scene Radiance, and Cold Space Radiance), and output Combined Radiance to the Michelson interferometer subsystem for modulation.

3.1.3.4 Convert Radiance to Analog

The Combined Radiance input from the scanning mirror/scene selection module is modulated in this function by the Michelson interferometer. The interferometer modulates the Reflected Radiance by first splitting the input radiance by using a beamsplitter module, sending the split radiance to reflector mirrors (one fixed, one moving), and reflecting the radiance from each mirror back to the beamsplitter to recombine and form the modulated signal, or interferogram. The changing optical path difference (OPD) caused by the moving mirror causes the modulation when the signals recombine. The output of this function is the Composite IR Interferogram.

The Composite IR Interferogram coming from the Interferometer is focused to an image on the sensor field stops by a telescope module. The IR interferogram is separated into the short-wave (SW), mid-wave (MW), and long-wave (LW) bands by an aft-optics module consisting of two dichroic mirrors. The output of this function is the set interferograms; SW MW LW Inteferograms.

The SW MW LW Inteferograms are imaged on the respective band detectors and converted to AC interferograms. Preamplifiers amplify the AC Interferograms and output the Analog Signal.

3.1.3.5 Convert Analog Signal To Digital

The Analog Signal from the preamps is accepted by the processing and control electronics, and the CrIS A/D conversion scheme quantizes/digitizes the interferogram. The output of this process is the Digital Signal, containing the interferogram of the modulated earth, space, or blackbody radiance.

3.1.3.6 Measure CrIS Health Status

The housekeeping electronics measures and digitizes critical temperatures, voltages, and currents for inclusion in the Health Status Data, and includes all data required for sensor status and health monitoring. This data includes:

- Sensor mode and configuration
- Sensor temperatures
- Sensor supply current and voltage
- Relay status, scan mirror rotation, and other rotating mechanism rates
- Other telemetry data required to support sensor performance evaluation

The Health Status Data is used to Control Sensor Operation and to Assemble CrIS Packets.

3.1.3.7 Assemble CrIS Packets

The CrIS assembles Data Packets from the inputs consisting of the Digital Signal, Health Status Data, Time Code, and Spacecraft Diary Info. The Packetized Data output, consisting of the telemetry and mission data, will be processed and formatted by the processing and control electronics to conform to the CCSDS Path Protocol Data Unit format. The Data Packets assembled by the CrIS from the Digital Signal, Health Status Data, and Spacecraft Diary Info will, at a minimum, include the following data information:

- Interferogram RDR packets (mission data)
- Telemetry RDR packets (housekeeping and diagnostics data)
- Calibration RDR packets (needed by algorithms to generate geolocated and spectrally/radiometrically calibrated SDRs).

3.1.3.8 Communicate with Spacecraft

The CrIS processing and control electronics communicates with the spacecraft across a command and telemetry data bus. From the spacecraft, the CrIS receives: CrIS Commands which is an output to Control Sensor Operation, Time Code for the Assemble CrIS Packets function and for Control Sensor Operation, Spacecraft Diary Information for incorporation into the CrIS data packets at Assemble CrIS packet function, and the CrIS ATMS Sync for scan synchronization through the Control Sensor Operations function. The communication interface receives the Packetized Data input following data packet assembly and outputs to the spacecraft Interferogram RDR packets, Telemetry RDR Packets, and Calibration RDR Packets.

3.1.3.9 Measure CrIS Temp

The Measure CrIS Temp function passively measures the CrIS instrument temperatures during all modes, even while the instrument is in the OFF mode. The CrIS Temp signal is sent to the spacecraft Generate Telemetry function.

3.1.3.10 Accommodate New Software Uplink

The Accommodate New Software Uplink function processes CrIS Software Uplinks received as instrument commands from the Spacecraft Validate and Process Commands function. The resulting new CrIS Software Executable is then provided to the Control CrIS Operation function.

3.1.4 ATMS Instrument

The purpose of the ATMS instrument is to collect microwave radiometric data that are used to obtain atmospheric parameters. In conjunction with the CrIS instrument, ATMS collects global observations that are used to obtain temperature and moisture profiles on a daily basis. The atmospheric radiances are collected using a passive microwave radiometer for bands within the microwave range of approximately 20-180 GHz and has a swath of 2300 km. Figure 3-10 details the ATMS dataflow.

Figure 3-10. ATMS Instrument DFD

3.1.4.1 Control ATMS Operation

The ATMS processing and control electronics module uses the measured Health Status data input from the sensor and the CrIS ATMS sync pulse, Time Code, and Commands inputs from the spacecraft to Control Sensor Operation, which encompasses all command and control functions for the ATMS instrument, including commanding operation modes. The nominal modes at this time are:

- OFF (Survival Heaters On):
Operational power to instrument is OFF, survival heaters ON (regulated by thermostats).

- POWER ON:
Operation power to instrument is ON, Control electronics ON, Housekeeping data ON, survival heaters ON (regulated by thermostats).

- POWER ON/RECEIVERS ON:
Operation power to instrument is ON, Control electronics ON, Housekeeping data ON, Receivers and channel electronics ON, survival heaters ON (regulated by thermostats).

- OPERATIONAL/MISSION OPERATION:
Operation power to instrument is ON, Control electronics ON, Housekeeping data ON, Receivers and channel electronics ON, Scan motor ON, Science data generated, survival heaters ON (regulated by thermostats).

- DIAGNOSTIC:

Operation power to instrument is ON, Other subsystems on for trouble shooting as required, Software updates if needed, survival heaters ON (regulated by thermostats).

- SAFE HOLD

Instrument is put in safe state by Control electronics after receiving SAFE HOLD signal from spacecraft (Stow antenna, Instrument control turns OFF the Scan motor, Receivers and channel electronics). A fixed time after receiving the SAFE HOLD signal (approximately 3 minutes) the spacecraft turns off operational power to the instrument, survival heaters ON (regulated by thermostats).

3.1.4.2 Generate On Board Calibration Radiance

A non-scene segment of scan is reserved for observation of a temperature controlled blackbody to provide a calibration of the signal path at a radiation level near full scale in the instrument dynamic range.

3.1.4.3 Scan Field of Regard

The atmosphere/Earth is observed through an angle that is nominally +/- 55degrees about the nadir in a path/direction that is orthogonal to the velocity vector of the spacecraft. Every third scan start time is synchronized with a CrIS scan start. The scan motion provides contiguous observations in the along-track direction. The different frequencies achieve different effective fields-of-view (FOV) that are all registered one to the other within the FOV of the lowest frequency.

3.1.4.4 Convert Radiance To Analog Signal

Combined Radiances are split into channels.

The microwave and milliwave Radiation are converted to Narrowband Signals using a subsystem array of feedhorns senses the electromagnetic radiation in 22 specified narrowband frequencies and applies the signal to the input of individual receivers for each frequency band.

The Narrowband Signals are converted to Analog Voltages. The sensed radiation is detected and amplified and conditioned in preparation for digital conversion as individual channels. This is a nearly linear process requiring characterization at subsystem and system level tests.

3.1.4.5 Convert Analog Signal to Digital

All analog channels have individual analog-to-digital converters that operate to generate a digital word per specified FOV. These digital words are presented to the instrument data formatting electronics.

3.1.4.6 Measure ATMS Health Status

The housekeeping electronics measures and digitizes critical temperatures, voltages, and currents for inclusion in the Health Status Data, and includes all data required for sensor status and health monitoring. This data includes:

- Sensor mode and configuration
- Sensor temperatures
- Sensor supply current and voltage
- Relay status, scan mirror rotation, and other rotating mechanism rates
- Other telemetry data required to support sensor performance evaluation

The Health Status Data is used to Control Sensor Operation and to Assemble ATMS Packets.

3.1.4.7 Assemble ATMS Packets

Signals from (1) the analog-to-digital converters (ADC), (2) from instrument housekeeping sensors, control operation, and status electronics, and (3) from spacecraft time and diary inputs are packetized for transmission to the spacecraft data interface. The formatting electronics transmits instrument packetized data to the spacecraft data system.

3.1.4.8 Communicate with Spacecraft

The ATMS processing and control electronics communicates with the spacecraft across a command and telemetry data bus. From the spacecraft, the ATMS receives: ATMS Commands which is an output to Control Sensor Operation, Time Code for the Assemble ATMS Packets function and for Control Sensor Operation, Space Diary Information for incorporation into the ATMS data packets at Assemble ATMS packet function, and the CrIS/ATMS Sync Pulse for scan synchronization through the Control Sensor Operations function.

Instrument to spacecraft transmission includes: the Packetized Data input following data packet assembly and outputs to the spacecraft ATMS Telemetry Pkts. and ATMS Science Pkts.

3.1.4.9 Measure ATMS Temp

A separate signal interface with the spacecraft is provided for instrument status signals that are derived independently of the instrument formatting electronics packets.

Passive measuring of the instrument temperature is done even while the sensor is in OFF mode and sent directly to the spacecraft.

3.1.4.10 Accommodate New Software Uplink

This is for the instruments to accommodate new software updates or upgrades transmitted from the spacecraft.

3.1.5 Instrument of Opportunity

Several IOOs are under consideration for inclusion in the NPP mission. The IOO is driven by the estimated availability of spacecraft mass and power resources while keeping within the target launch vehicle (NASA MedLite-class). Technical factors which must be considered for each of the IOO candidates is synergy with the baseline payload from a risk-reduction and science standpoint, spacecraft resource requirements of candidate instruments (mass, power, volume, field-of-view, data rate, pointing control and knowledge, and pointing stability) and the operational complexity of candidate instruments. Programmatic factors that must be considered are the schedule impact to the NPP mission, the availability of the candidate instrument, and the cost impact to the space segment and ground segments of the NPP mission. At present, no decision has been made regarding whether to fly an IOO on NPP, or what the IOO might be. Candidates under study include a GPS-occultation instrument for tropospheric measurements, and the NPOESS Ozone Mapping Profiler Suite (OMPS). It is anticipated that NASA and IPO will jointly determine whether to incorporate an IOO, and which instrument to accommodate.

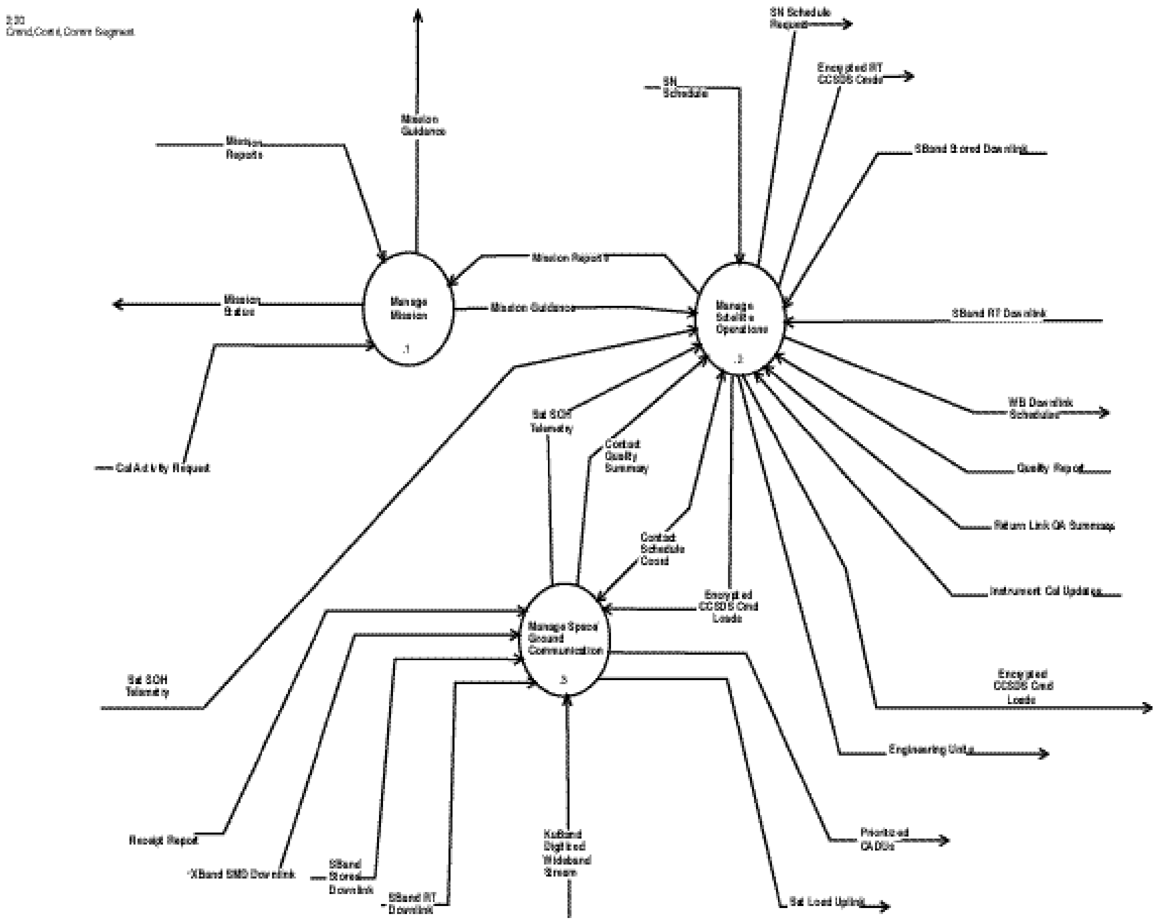
3.1.6 Ground Support Equipment

The GSE originates Test Commands internally for observatory level integration and test support and receives Test Commands externally from Launch Services and for launch site preparations. The Test Commands are sent to the Authenticate Commands function within the Provide Narrowband Communications function of the Spacecraft. Test Telemetry originating in the Generate Telemetry function of the Provide Narrowband Communications function of the Spacecraft is sent to the GSE. The Test Telemetry is used internally by the GSE in spacecraft integration and test analysis and sent to Launch Services for launch site preparations.

3.2 COMMAND, CONTROL, AND COMMUNICATION SEGMENT

The C3S is described within three high level functional processes (See Figure 3-11). They are:

- Manage Mission
- Manage Satellite Operations
- Manage Space/Ground Communication.



CH-02

Figure 3-11. CMND, CONTROL, COMM Segment DFD

3.2.1 Manage Mission

The Manage Mission function has the authority and responsibility to execute NPP operational requirements. It is the single functional entity responsible for all satellite operations guidance and daily operational oversight of NPP. The Manage Mission function receives Mission Reports from the Manage IDPS function and the SDS Manage and Monitor Resources function. The Manage Mission function also receives Calibration Activity Requests from the SDS Process Calibration Data function. This information is evaluated, assimilating the information into Mission Guidance (prioritization, satellite maneuver for calibration purposes, mission configuration changes, etc.). The Mission Guidance is sent to the Manage Satellite Operations function, the Manage IDPS function, and the SDS Manage and Monitor Resources function and the ADS Manage Archive Function for use in performing their respective operations activities.

3.2.2 Manage Satellite Operations

The Manage Satellite Operations function is further decomposed into nine lower level functions (Figure 3-12). They are:

- Plan Mission Events

- Build Command Sequence
- Maintain Satellite Databases
- Monitor and Control Satellite
- Prepare and Send Satellite Command Loads
- Perform Engineering and Analysis
- Analyze Flight Dynamics
- Simulate Satellite
- Maintain Flight Software.

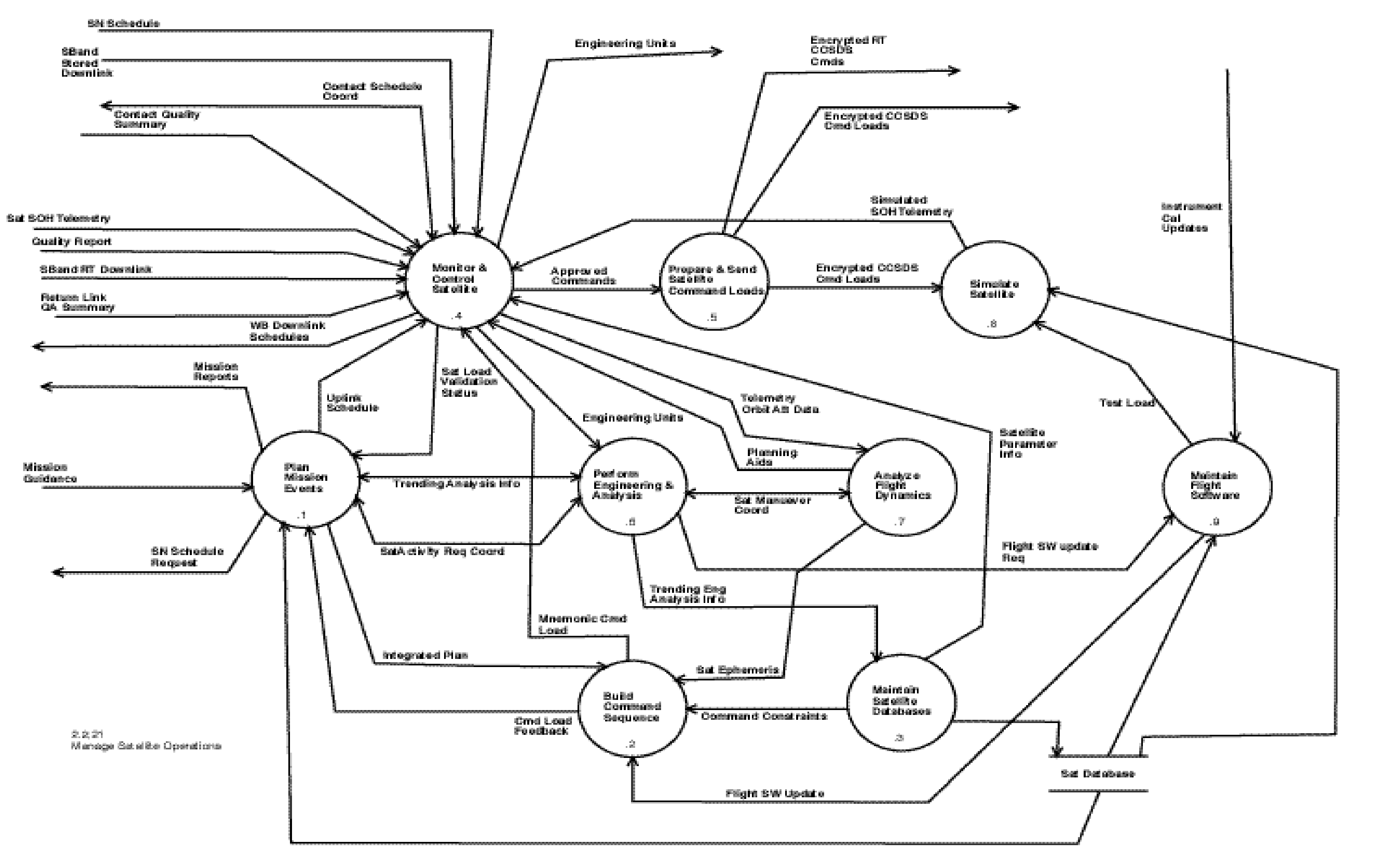


Figure 3-12. Manage Satellite Operations DFD

CH-02

3.2.2.1 Plan Mission Events

This function utilizes mission guidance to conduct routine and emergency mission planning. The Mission Manager provides mission guidance and requirements. The schedule of uplink activity is provided to Monitor and Control Satellite. Satellite loads are validated by the Monitor and Control Satellite function and status is provided back to Plan Mission Events. Perform Engineering & Analysis provides Trending Analysis feedback to Plan Mission Events. All satellite activities require coordination between Plan Mission Events and Perform Engineering & Analysis. The automated Integrated Plan is forwarded to Build Command Sequence for execution.

3.2.2.2 Build Command Sequence

This function builds all spacecraft commands for nominal and emergency satellite operations. The Integrated Plan is received from Plan Mission Events for execution. Spacecraft Ephemeris and any Command Constraints are utilized in the Build Command Sequence. Command Load Feedback is sent to Plan Mission Events and the Mnemonic Command Loads are sent to Monitor & Control Satellite for real time spacecraft telemetry monitoring. Changes and Updates to Flight Software are received by Build Command Sequence from maintain Flight Software.

3.2.2.3 Maintain Satellite Databases

This function maintains all ground satellite databases and provides a baseline for all contingency commanding. It is maintained to reflect the current state of the satellite. Trending Engineering Analysis is received from Perform Engineering & Analysis. Maintain Satellite Databases utilizes this data to set Command Constraints for Build Command Sequence and sends updates in Spacecraft Parameter Information to Monitor & Control Satellite. All Maintain Satellite Database changes are forwarded to the Sat Database.

3.2.2.4 Monitor and Control Satellite

This function consists of satellite State-of-Health (SOH) verification, satellite navigation and attitude determination, stored mission data recovery and other commanding necessary to operate and maintain the on orbit satellite. During anomalous periods this includes execution of pre-approved contingency procedures and or commands as directed by mission management. Monitor and Control Satellite receives the Uplink Schedule from Plan Mission Events. Daily or weekly coordination is accomplished via Contact Schedule Coordination. The SN schedule is provided to Monitor and Control CH-01
Satellite for review. Commanding requires an accurate Mnemonic Command Load and Spacecraft Parameter Information. Planning Aides are utilized as required. Monitoring of the Spacecraft begins with the receipt of Sband RT Downlink and Sband stored Downlink. Spacecraft SOH Telemetry is monitored and limit checked. Telemetry Orbit Attitude data are provided to Analyze Flight Dynamics for analysis. If commanding is required, Approved Commands are sent to Prepare and Send Satellite Command Loads for transmission. If required, Engineering Units are sent to Perform Engineering and Analysis and to the SDS. When commanding is complete Spacecraft Load Validation CH-02
Status is sent to Plan Mission Events. The Wideband (WB) Downlink Schedules are sent in advance to prepare for data receipt. When the satellite contact is completed, the

Return Link Quality Assurance (QA) Summary is provided to Monitor and Control Satellite for review and or action. A Contact Quality Summary is provided to Monitor and Control Satellite for analysis and trouble shooting. A Quality Report for SN support contacts are submitted to Monitor and Control Satellite. For testing and anomaly resolution, Simulated SOH Telemetry is sent to Monitor and Control Satellite. CH-02

3.2.2.5 Prepare and Send Satellite Command Loads

This function receives Approved Commands from Monitor and Control Satellite and formulates them into Encrypted RT CCSDS Commands that are transmitted to the spacecraft. During the preparation of command loads, prior to the start of a realtime contact, Encrypted CCSDS Command Loads are sent to Simulate Satellite for verification and validation. During the realtime contact validated Encrypted CCSDS Command Loads are transmitted to the satellite.

3.2.2.6 Perform Engineering and Analysis

This function receives engineering data from each satellite contact for analysis. Engineering Units are sent from Monitor and Control Satellite during every satellite contact. Perform Engineering and Analysis provides Trending Analysis to Plan Mission Events and Trending Engineering Analysis to Maintain Satellite Databases to update or change a spacecraft database (as required). Engineering and Analysis coordinate on all (as required) Spacecraft Maneuvers with Analyze Flight Dynamics. All other Spacecraft Activity Required is coordinated with Plan Mission Events.

3.2.2.7 Analyze Flight Dynamics

This function analyzes all flight attitude data from each satellite contact via satellite state-of-health telemetry. Telemetry Orbit Attitude Data are received from Monitor and Control Satellite. Analyze Flight Dynamics determines if a correction is required and coordinates a corrective Spacecraft Maneuver with Perform Engineering and Analysis. Analyze Flight Dynamics sends Spacecraft Ephemeris to Build Command Sequence for execution. Analyze Flight Dynamics provides Planning Aids to Monitor and Control Satellite for all nominal and non-nominal satellite operations.

3.2.2.8 Simulate Satellite

This function simulates all aspects of satellite flight. All non-routine commanding utilizes this resource for validation prior to actual command transmission. Encrypted CCSDS Command Loads are sent from Prepare and Send Satellite Command Loads to Simulate Satellite for verification and validation. Simulate Satellite sends Simulated SOH Telemetry to Monitor and Control Satellite for anomaly resolution, launch and early orbit preparation, and training. Maintain Flight Software sends Test Load(s) to Simulate Satellite to test and analyze new software configurations.

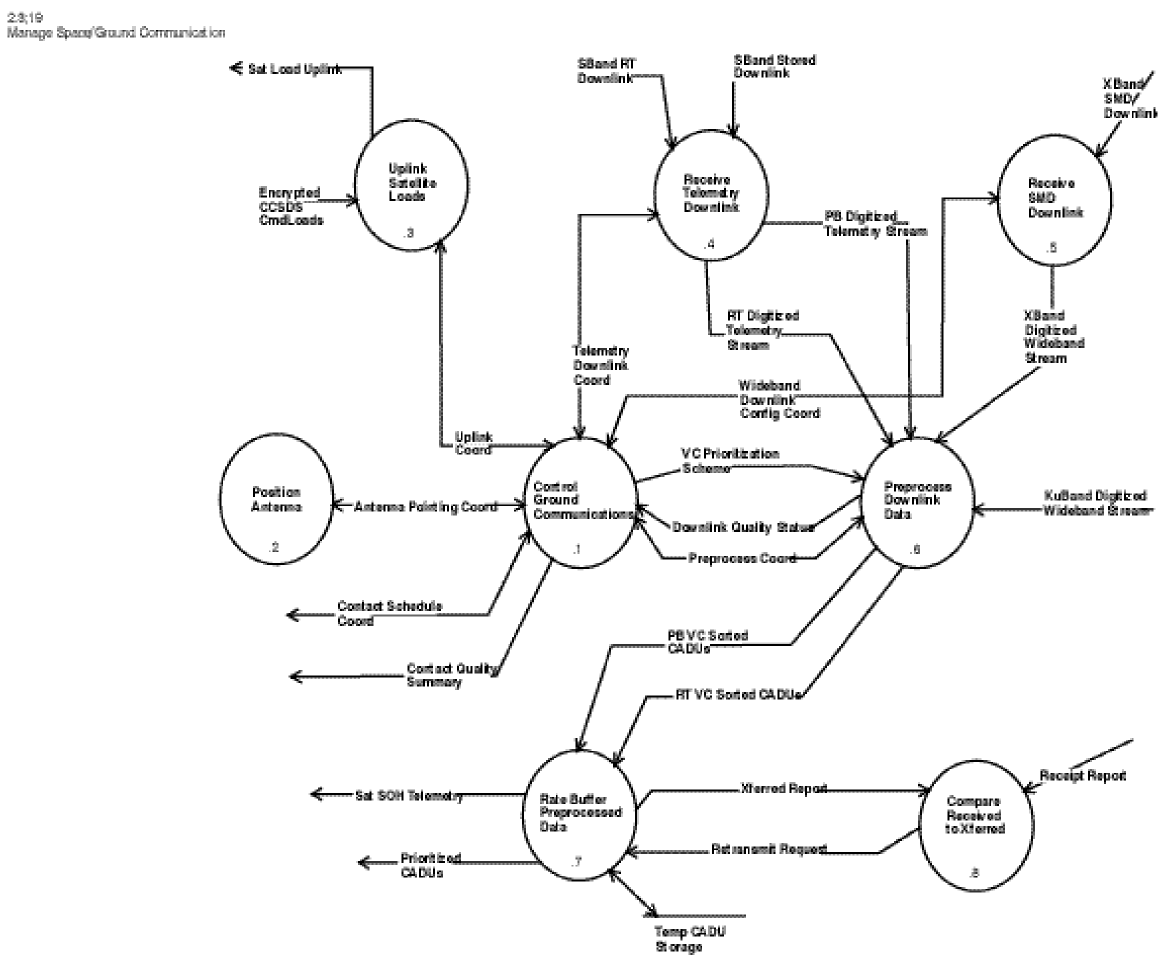
3.2.2.9 Maintain Flight Software

This function maintains the current flight software configuration. Maintain Flight Software receives Flight Software Updates Requests from Perform Engineering and Analysis and generates flight software changes based requests and Sat Database inputs from the IDPS. Instrument Calibration Updates are provided from the IDPS. If updates are required Maintain Flight Software sends a Flight Software Update to Build Command Sequence for subsequent uplink to the satellite.

3.2.3 Manage Space/Ground Communication

Manage Space Ground Communication provides the primary communication links between the Manage Satellite Operations function and the Satellite. This function is further decomposed into eight lower level functions shown in Figure 3-13. They are:

- Control Ground Communications
- Position Antenna
- Uplink Satellite Loads
- Receive Telemetry Downlink
- Receive SMD Downlink
- Pre-process Downlink Data
- Rate Buffer Pre-processed Data
- Compare Received to Transferred Data.



CH-02

Figure 3-13. Manage Space/Ground Communications DFD

3.2.3.1 Control Ground Communications

Control Ground Communications receives requests for Contact Schedule Coordination with the Satellite from the Monitor and Control Satellite function. Details of the contact schedule (e.g. frequency selection, antenna pointing, uplink configuration, rate buffer prioritization) are negotiated and confirmed as part of this coordination activity. Minutes prior to a scheduled contact, the Control Ground Communications function statuses the other functions within Manage Space/Ground Communication and provides configuration parameters for the impending pass. Upon successful configuration, the other functions report back to the Control Ground Communications function confirming readiness to execute the pass.

During the pass, Control Ground Communications receives continuous status from the other functions within Manage Space/Ground Communications and specifically Downlink Quality Status from the Preprocess Downlink Data function. This information is summarized into a Contact Quality Summary and is forward to the Monitor and Control Satellite function. Failures to achieve or maintain readiness are resolved by the Control Ground Communication function in coordination with the Monitor and Control Satellite function (if necessary).

3.2.3.2 Position Antenna

Antenna Pointing Coordination occurs between the Control Ground Communications function and the Position Antenna function before/during a scheduled pass, and is summarized as follows.

Position Antenna receives pointing parameters from the Control Ground Communications function minutes prior to an impending pass. The Position Antenna function performs an automated self-check, points the antenna to the appropriate position and reports readiness back to Control Ground Communications. The Position Antenna maintains the correct pointing angle during the pass and reports any anomalies back to the Control Ground Communications function.

3.2.3.3 Uplink Satellite Loads

Uplink Coordination between Uplink Satellite Loads and the Control Ground Communications function enables the set up and monitoring of the activities associated with uplinking commands to the satellite. Minutes prior to an impending pass, Uplink Satellite Loads receives configuration information (e.g. uplink frequencies, modulation schemes, data routing activities) from the Control Ground Communications function. The Uplink Satellite Loads function configures for the pass and reports readiness back to Control Ground Communications.

During the pass, Uplink Satellite Loads receives Encrypted CCSDS RT Cmds and/or Encrypted CCSDS Cmd Loads from the Prepare and Send Satellite Command Loads function within Manage Satellite Operations. The Uplink Satellite Loads function encodes/modulates the CCSDS Commands and converts the stream into a SC Load Uplink in the form of an RF signal, which is received by the Receive Narrow Uplink function within the Satellite.

3.2.3.4 Receive Telemetry Downlink

Telemetry Downlink Coordination between Receive Telemetry Downlink and the Control Ground Communications function enables the setup and monitoring of the activities associated with receiving the telemetry downlinked by the Satellite. Minutes prior to an impending pass, Receive Telemetry Downlink receives configuration information (e.g. downlink frequencies, demodulation schemes, decoding schemes) from the Control Ground Communications function. The receive Telemetry Downlink function configures for the pass and reports readiness back to Control Ground Communications.

During the pass, Receive Telemetry Downlink receives Sband RTDownlink and/or Sband Stored Downlink signal(s) from the Downlink Narrowband function of the Satellite. These signals are demodulated/decoded and digitized into the RT Digitized Telemetry Stream and/or the PB Digitized Telemetry Stream and transferred immediately to the Preprocess Downlink Data function.

3.2.3.5 Receive SMD Downlink

Wideband Downlink Coordination between Receive SMD Downlink and the Control Ground Communications function enables the setup and monitoring of the activities associated with receiving the SMD downlinked by the Satellite. Minutes prior to an impending pass, Receive SMD Downlink receives configuration information (e.g. downlink frequencies, demodulation schemes, decoding schemes) from the Control Ground Communications function. The Receive SMD Downlink function configures for the pass and reports readiness back to Control Ground Communications.

During the pass, Receive SMD Downlink receives the SMD Downlink signal from the Downlink Wideband Data function of the Satellite. These signals are demodulated/decoded and digitized into the Digitized Downlink Stream and transferred immediately to the Preprocess Downlink Data function.

3.2.3.6 Pre-process Downlink Data

Preprocess Coordination between Pre-process Downlink Data and the Control Ground Communications function enables the setup and monitoring of the activities associated with preprocessing digitized telemetry and SMD data. Minutes prior to an impending pass, Pre-process Downlink Data receives configuration information (e.g. CCSDS format parameters, Virtual Channel sorting priorities) from the Control Ground Communications function. The Pre-process Downlink Data function configures for the pass and reports readiness back to Control Ground Communications.

During the pass, Pre-process Downlink Data receives the RT Digitized Telemetry Stream, and the PB Digitized Telemetry Stream from the Receive Telemetry Downlink function, and the Digitized Wideband Stream from the Receive SMD Downlink function. These streams are frame synchronized into CADUs, error corrected (when possible), and sorted by virtual channel (VC) based on the priorities provided by the Control Ground Communication function. The RT VC Sorted CADUs and PB VC Sorted CADUs are transferred immediately to the Rate Buffer Pre-processed Data function. A near realtime Downlink Quality Status is provided back to the Control Ground Communications function during the preprocessing of the downlinked data.

3.2.3.7 Rate Buffer Pre-processed Data

PB VC sorted CADUs and RT VC sorted CADUs are received by the Rate Buffer Pre-processed Data function from the Pre-process Downlink Data function and temporarily stored. The Rate Buffer Pre-processed Data functions forwards all SC SOH Telemetry CADUs in near realtime to the Monitor and Control Satellite function. The Rate Buffer Pre-processed Data function also transfers the stored Prioritized CADUs to the Ingest Data Function within the IDPS. Upon transfer of the Prioritized CADUs, the Rate Buffer Pre-processed Data function sends a Xferred Report to the Compare Received to Xferred function summarizing the rate buffering activity.

3.2.3.8 Compare Received to Transferred Data

The Compare Received to Transferred Data function receives Xferred Reports from the Rate Buffer Pre-processed Data function and Receipt Reports from the Ingest Data function within IDPS. These reports are analyzed for discrepancies to determine if a Retransmit Request needs to be sent the Rate Buffer Preprocessed Data function.

3.2.4 Route Mission Data

Routing of mission data within and between segments is a critical activity. The NPP mission relies on high-performance networks to route satellite commands, state of health telemetry and stored mission data quickly and reliably. While mission data routing is an activity within the C3S, the function is implied for DFD simplicity. Therefore explicit functions and specifications are omitted from the system concept but are included within the NPP Mission (Level 2) Requirements.

3.3 INTERFACE DATA PROCESSING SEGMENT

The IDPS for NPP is planned to be an early implementation of the NPOESS IDPS. The IDPS ingests data from the C3S, removes the communications artifacts and produces RDRs, SDRs, and EDRs. The data records are then provided to the Application Processing Systems, located at the five Centrals, for specific use in weather application processing and to the SDS for specific global climate change processing. All data are provided to the ADS for archive and distribution to the user communities. The IDPS is also responsible for the operational calibration of the NPP instruments. Figure 3-14 describes the IDPS data flow.

Figure 3-14. Interface Data Processing Segment DFD

3.3.1 Manage IDPS

The Manage IDPS function provides for internal IDPS system management and administration. It provides centralized tracking and event coordination with respect to scheduling, system status, and reporting.

The Manage IDPS function accepts Mission Guidance from the C3S Manage Mission function and WB Downlink Schedules from the C3S Manage Satellite Operations function which are used for IDPS planning and scheduling purposes.

The Manage IDPS function generates management summary reports at each major processing milestone, and provides Mission Reports to the C3S Manage Mission function. This information is gathered from the Ingest Status, Storage Status, Processing Status, and Distribution Status. Control messages are used to control the processing and distribution of the data (Ingest Control, Processing Control, Distribution Control and Storage Control).

3.3.2 Ingest Data

The Ingest Data function accepts all mission data (as Prioritized CADUs) on arrival from the C3S Rate Buffer Pre-Processed Data function, creating orbital-duration, time-referenced, sensor-specific RDRs for each sensor or subsystem. The Ingest Data function removes the communication structure and artifacts, time orders the sensor data, and removes redundant data as necessary to create the RDRs. The ingest data function also generates metadata for storage, process tracking, and cataloguing purposes. The RDRs and associated metadata are forwarded to the Manage IDPS Store function. The link quality assessment in the form of the Return Link QA Summary is forwarded to the C3S Monitor and Control Satellite function.

The Ingest Data function also generates a Receipt Report that is provided back to the C3S Manage Space/Ground Communications function. This report is used to verify that all data transmitted to the IDPS has been received.

The ingest data function accepts Ancillary Data from external data providers to be used as input for the processing of the SDRs and EDRs. The Ingest Data function validates the received ancillary data for form, fit, and content and provides the Validated Ancillary Data to the Manage IDPS Store as well.

Ingest Control and Ingest Status information is exchanged with the Manage IDPS function to control the ingest function and to track the status of ingest processes.

3.3.3 Manage Store

The Manage Store function manages system storage devices to facilitate timely flow of IDPS data processing. Manage Store function receives Validated Ancillary Data and RDRs from the Ingest Data function. Data acquired during calibration events or specifically selected data, considered Calibration RDRs, are provided to the Perform Offline Calibration Processing. Application Processing Coefficients are received from the Perform Offline Cal Processing function. Manage Store function then provides Stored Ancillary Data and Stored RDRs to Process Data Records function for subsequent processing into SDRs and EDRs. SDRs and EDRs are returned to Manage Store function upon processing completion.

Storage Control information is received from the Manage IDPS function to provide resource and schedule management of data storage activities. Storage Status is returned to track the status of the storage processes and resources.

The Manage Store function provides Stored Data to the Format and Distribute Data function.

3.3.4 Process Data Records

The Process Data Records function (Figure 3-15) is the heart of the IDPS. For any product, the appropriate algorithmic process is combined with required input files (dynamic or static) to create the SDRs and EDRs. The Process Data Records is composed of the following functions:

- Monitor/Manage Resources
- Produce SDRs
- Produce Sounder Data
- Produce Cloud Products
- Produce Aerosol Products
- Produce Land Products
- Produce Surface Temperature Products
- Produce Snow/Ice Products
- Produce Ocean Products

Figure 3-15. Process Data Records DFD

3.3.4.1 Monitor/Manage Resources

The Monitor/Manage Resources function provides the processing coordination for the IDPS and provides the interface to other IDPS functions for the completed products.

This function receives Processing Control Information from the Manage IDPS function and if necessary provides direction to the Produce SDRs function which is the first processing step. All other processing occurs as soon as the prerequisites for product generation are met. Processing Status is monitored by tracking the contents of the Temporary Data Store and this data is passed back to the Manage IDPS function for inclusion in mission reports.

The Monitor Manage Resources provides SDRs and EDRs to the Manage Store function as product generation completes.

3.3.4.2 Produce SDRs

The Produce SDRs function (Figure 3-16) reformats, time orders, calibrates and geo-locates ATMS, VIIRS, and CrIS sensor data with inputs from Stored RDRs, Stored Ancillary Data, and Application Processing Cal Coefficients files. Specifically Produce SDRs is comprised of the following lower level functions:

- Decompress Data
- Reformat RDRs
- Process Internal Calibration Data
- Apply Radiometric Calibrations
- Determine Geolocation

Figure 3-16. Produce SDRs DFD

3.3.4.2.1 Decompress Data

The Decompress Data function ingests Stored RDRs that are compressed by the individual instruments and decompresses the data with the corresponding decompression algorithms. Decompressed Data is then provided to Reformat RDRs function.

Processing Direction is passed to this function from the Monitor/Manage Resources function. This provides information on processing priorities, where data are located, and any other parameters necessary for processing.

3.3.4.2.2 Reformat RDRs

The Reformat RDRs function receives Decompressed Data and places the data into formats (Reformatted RDRs) that will facilitate further processing. The Reformat RDRs function also forwards Internal Cal Data to the Process Internal Cal function.

3.3.4.2.3 Process Internal Calibration Data

Internal Cal Data, raw data records generated by the instruments while looking at on-board calibration sources, are processed to create gains and biases used to calibrate the radiometric response of each of the various instrument(s) detectors. The Processed Calibration Data is forwarded to the Apply Radiometric Corrections function for use in the radiometric correction algorithms.

3.3.4.2.4 Apply Radiometric Calibrations

Radiometric corrections are applied to the Reformatted RDRs. The gains and offsets used in the application can be determined by using the calibration coefficients from the Processed Cal Data or the calibration coefficients that are included in the Application Processing Cal Coefficients received from the Perform Offline Calibration Processing function.

Radiometrically Corrected Data are passed to the geolocation function.

3.3.4.2.5 Determine Geolocation

The Geolocation of the Radiometrically Corrected Data is determined using position attitude and time information provided in the spacecraft state of health data that is downlinked with the science data and any ground control pointing and digital elevation models (DEMs) necessary, as stored Ancillary Data, to complete the function. The radiometrically corrected, geolocated SDRs are then provided to the temporary storage for use in EDR processing.

3.3.4.3 Produce Sounder Data

The Produce Sounder Data function generates sounder products from the CrIS and ATMS product types. Atmospheric EDRs consisting of atmospheric vertical moisture profiles, atmospheric vertical temperature profiles, and surface pressure vertical profiles are temporarily stored in Temporary Data Store.

3.3.4.4 Produce Cloud Products

The Produce Cloud Products function generates cloud products from the VIIRS Calibrated Radiances and vertical moisture, temperature, and pressure profiles. Stored Ancillary Data may be used as input for processing. Cloud EDRs consisting of cloud-effective particle size, cloud layers, clear optical thickness, cloud top height, cloud top pressure, cloud top temperature, and cloud base height EDRs are temporarily stored in Temporary Data Store.

3.3.4.5 Produce Aerosols Products

The Produce Aerosols Products function generates aerosol products from VIIRS and vertical pressure profile product types. Stored Ancillary Data may be used as input for processing. Aerosol EDRs consisting of aerosol particle size, aerosol optical thickness, precipitable water, and suspended matter EDRs are temporarily stored in Temporary Data Store.

3.3.4.6 Produce Land Products

The Produce Land Products function generates land products from the VIIRS sensor data records vertical pressure profile, and Stored Ancillary Data and DEMs, Land Mask

Projections, etc. Land EDRs consisting of: vegetation indices, surface albedo, surface, classification, soil moisture, and imagery EDRs are temporarily stored in Temporary Data Store.

3.3.4.7 Produce Surface Temperature Products

The Produce Surface Temperature Products function generates surface temperature products from VIIRS sensor data records, Stored Ancillary Data, vertical moisture and temperature profiles and surface emissivity maps. Surface Temperature EDRs consisting of: sea surface temperatures, land surface temperatures, active fire products and ice surface temperatures are temporarily stored in Temporary Data Store.

3.3.4.8 Produce Snow and Ice Products

The Produce Snow and Ice Products function generates snow/ice products from VIIRS sensor data records, Stored Ancillary Data, temperature profiles, surface temperature and reflections. Snow/Ice EDRs consisting of Sea ice edge motion, snow cover depth, and fresh water ice EDRs are temporarily stored in Temporary Data Store.

3.3.4.9 Produce Ocean Products

The Produce Ocean Products function generates ocean products from VIIRS sensor data records, Stored Ancillary Data sea surface temperature, and surface pressure. Ocean EDRs consisting of: Net heat flux, littoral sediment, ocean color chlorophyll, and ocean currents EDRs are temporarily stored in Temporary Data Store.

3.3.5 Format and Distribute Data

The Format and Distribute Data function handles data delivery. Stored Data are reformatted as needed to the distribution interface standard. Product Subscriptions generate a standing order for specified RDRs, SDRs, and EDRs, within specified temporal and spatial limits. The RDRs, SDRs, and EDRs and the Application Processing Cal Coeffs are provided to the ADS for archive and for distribution to the user community. Transfer coordination (Xfer Coord) takes place with the ADS to insure the successful delivery of the data to the archive.

Application Processing Cal Coeffs and RDRs are provided to the SDS, while RDRs, SDRs, and EDRs are provided to the Application Processing Systems (i.e. Centrals).

Distribution Control and Distribution status is exchanged with the Manage IDPS function to provide guidance on the distribution processing and to ascertain the status of the distribution processes and resources.

3.3.6 Perform Offline Calibration Processing

The Perform Offline Calibration Processing provides the operational calibration and validation functions for the NPP instruments.

Calibration RDRs collected from calibration events or from selected sites are processed and trended to evaluate instrument performances. As necessary, new Application Processing Cal Coefficient tables are generated and provided to the Manage Store function. Based on the calibration evaluation, updates to the calibration tables on board the NPP satellite may be required. This function determines when such action is necessary and provides the Instrument Cal Updates to the Manage Satellite Operations function within the C3S for coordination and upload to the satellite.

This function receives Science Cal Coefficients Files from the SDS. These calibration coefficients are evaluated for usage within the application processing.

3.4 SCIENCE DATA SEGMENT

The SDS provides the functions necessary to produce NASA-sponsored science products, or climate data records, not required by the operational community. To meet science requirements, the NPP mission will largely leverage off the products and services provided by the IDPS and the ADS. However, there are certain science requirements that will not be satisfied by those segments. These include the capability to reprocess all data collected in the archive, the ability to generate products unique to the climate research community (e.g. weekly, monthly, and annual products) and the ability to generate NASA-sponsored science climate records for all EDRs given the performance and other operational considerations of the IDPS. Therefore the SDS will provide the following functionality:

- Ingest RDRs provided by the IDPS
- Process all RDRs to Level 1B science quality products
- Science Calibration Processing
- Generate select Higher Level Science Quality Climate Data Records (uses competitive Announcement of Opportunity [AO] process)
- Provide Level 1B and Climate Products to ADS
- Provide storage of the NPP data for the life of mission
- Provide reprocessing capabilities
- Schedule and manage SDS resources

Figure 3-17 details the SDS dataflow.

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other types of printers.

Figure 3-17. Science Data Segment DFD

3.4.1 Manage and Monitor Resources

The Manage and Monitor Resources function receives Mission Guidelines from the Manage Mission function of the C3S. These guidelines include science processing priorities and reprocessing direction from the mission manager. The Manage and Monitor Resources function interacts with the internal SDS functions to react and respond to those guidelines and to accomplish the daily processing tasks. This interaction is accomplished by providing schedules to the internal functions in the form of Ingest Control, Reprocessing Requests, Processing Control, and Calibration Processing Control.

The Manage and Monitor Resources function assimilates Mission Reports for the Manage Mission function. These reports will include information on the system performance, and production status. Inputs from the Calibration Reports, Ingest Status, Production Status, Mission Storage Status, and Format Distribution Status go into the generation of the Mission Reports.

The Manage and Monitor Resources function provides Xfer Coord with the ADS. This coordination will verify that the science products are successfully placed into the archive and made available for distribution to the user community.

The Manage and Monitor Resources function also provides Product Subscriptions to the IDPS as a standing request for delivery of all the RDRs that are generated within the IDPS functions.

Reprocessing Requests for individual products can also be made by the Produce Climate Data Records function.

3.4.2 Ingest RDRs

The Ingest RDRs function provides for the ingest of RDRs from the IDPS. A basic level validation of the RDRs is performed. This validation includes such functions as validating that the data received are the data that was expected, and that the received data are in the appropriate format and complete. The Validated RDRs are then provided to the ProduceLevel1B Products function for further processing. Calibration RDRs are provided to the Process Calibration Data process. All validated RDRs are placed into the SDS Mission Storage

To support the ingest of RDRs, schedules (Ingest Control) are received from the IDPS Manage/Monitor Resources function. This provides information on when data will be available for ingest and validation.

Ingest Status is generated and provided to the Manage/Monitor Resources function.

3.4.3 Produce Level 1B Products

The Produce Level 1B Products is further decomposed into seven lower level functions (Figure 3-18). They are:

- Manage SDS Processing
- Decompress Data
- Generate Granules
- Process Internal Calibration Data
- Apply Radiometric Corrections
- Determine Geolocation/Browse
- Ingest SDS Ancillary Data.

Figure 3-18. Produce Level 1B Products DFD

3.4.3.1 Manage SDS Processing

The Manage SDS Processing function coordinates the Level 1B processing within the SDS. SDS Processing Control is received and provides information for the data to be processed, such as location and processing parameters. This Processing Information is provided to the first step in the production process (Decompress Data). Reprocessing Requests are received and based on the request and available resources; a Staging Request is generated in order to retrieve the necessary data from the mission storage.

This function also provides Schedule Ancillary Ingest to get the latest ancillary data required for science processing from external sources.

This function also monitors the Level 1B processing and reports status and error conditions in Production Status to the Manage and Monitor Resources.

3.4.3.2 Decompress Data

The Decompress Data function ingests Validated RDRs that are compressed by the individual instruments and decompresses the data with the corresponding decompression algorithms. Decompressed Data is then provided to the Generate Granules function.

Staged Data, which are RDR data that is stored in the mission storage, can also be ingested to the function for reprocessing.

Processing Information is passed to this function from the Manage Processing function. This provides information on what data should be processed (or reprocessed), where the data are located, and any other parameters necessary for processing.

3.4.3.3 Generate Granules

Decompressed Data are input to this function. Data overlap across and within contacts is removed and the data is formatted and grouped into granules that are suitable for further processing with the SDS. The granules are then passed to the Apply Radiometric Corrections function. Internal Cal Data is also provided to the Process Internal Cal data function.

3.4.3.4 Process Internal Calibration Data

Internal Cal Data, RDRs generated by the instruments while looking at on-board calibration sources, are processed to create gains and biases used to calibrate the radiometric response of each of the various instrument(s) detectors. The Processed Calibration Data is forwarded to the Apply Radiometric Corrections function for use in the radiometric corrections algorithms.

3.4.3.5 Apply Radiometric Corrections

Radiometric corrections are applied to the data to generate the Level1B data products. The gains and offsets used in the application can be determined by using the calibration coefficients from the Processed Calibration Data or the calibration coefficients that are included in the Science Cal Coefficients received from the Process Calibration Data function.

Trending Parms are kept for selected processed data and provided to the science calibration functions for trending and analysis purposes.

Radiometrically Corrected Data is provided to the next step for geolocation.

3.4.3.6 Determine Geolocation/Browse

The geolocation of the Radiometrically Corrected data is determined using position, attitude, and time information provided in the spacecraft state of health data that is downlinked with the science data and any ground control pointing and DEMS necessary to achieve the desired accuracy.

Browse data for image products and metadata are generated and the entire Level 1B Data Package is provided to the Format Data and Distribute function.

3.4.3.7 Ingest and Store SDS Ancillary Data

This function receives Schedule Ancillary Ingest direction from the Manage SDS Processing function. Based upon the schedule, the function retrieves the ancillary data necessary to perform science data functions. The data are validated for data format and completeness and the Validated Ancillary Data is provided to the geolocation and Produce Climate Data Records functions as well as to the ADS for archive.

3.4.4 Process Calibration Data

The SDS Process Calibration function (Figure 3-19) supports the science Calibration and Validation functions for NPP. This function is decomposed as follows:

- Process Lunar Calibration Data
- Process Deep Space Calibration Data
- Process Ground Look Calibration Data
- Process Internal Calibration Data
- Process Internal Calibration/Blackbody Data
- Perform Geometric Calibration and Characterization
- Analyze and Evaluate Data
- Plan Calibration Events
- Generate Science Processing Coefficients.

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other types of printers.

Figure 3-19. Process Calibration Data DFD

3.4.4.1 Ingest Data

Trending Parms are ingested from the Produce Level 1B Products function and stored in the Char Cal Statistics data store for use in the analysis and evaluation of system performance.

Application Processing Cal Coeffs are ingested from the IDPS Format and Distribute Data or Perform Offline Calibration Processing functions. These are the calibration coefficients used in the application processing, and serve as the basis for the science calibration coefficients that are generated in the Generate Processing Coeffs function.

3.4.4.2 Process Lunar Calibration Data

Lunar RDRs, raw data records generated by the instruments while looking at the moon, are processed to create Gains Biases used to calibrate the radiometric response of each of the various instruments detectors.

3.4.4.3 Process Deep Space Calibration Data

Deep Space Look RDRs, raw data records generated by the instruments while looking at deep space, are processed to create Gains Biases used to calibrate the radiometric response of each of the various instruments detectors.

3.4.4.4 Process Ground Look Calibration Data

Ground Cal RDRs, raw data records generated by the instruments while looking at a radiometric ground calibration site, are processed to create Gains Biases used to calibrate the radiometric response of each of the various instruments detectors. This may occur during a campaign where radiometric observations are being gathered on the ground and thus can be used to further characterize and calibrate the NPP instruments.

3.4.4.5 Process Internal Calibration/Black Body Data

Validated Cal RDRs, raw data records generated by the instruments while looking at on-board calibration sources, are processed to create Gains Biases used to calibrate the radiometric response of each of the various instrument detectors.

3.4.4.6 Perform Geometric Calibration/Characterizations

The Perform Geometric Calibration/Characterizations function processes Geometric Site RDRs to determine the band-to-band registration parameters, determine the misalignment between the spacecraft and the payloads, and to characterize the along and across track parameters for the instruments. The results of the processing are stored in the Char Cal Statistics data store for later retrieval and analysis.

3.4.4.7 Analyze and Evaluate Data

The Analyze and Evaluate Data function examines the performance of the satellite, instruments, and ground processing procedures with respect to image geometry and radiometry from a science perspective. This is accomplished by analyzing the Gains Biases generated from the various calibration sources available for the mission.

The characterization and calibration statistics (Char Cal Stats) are trended to assess radiometric response, accuracy, band-to-band registrations and other short and long term performance.

Processed Calibration Data is provided to the Format Data and Distribute function for formatting and forwarding to the Mission Storage contained within the SDS.

Evaluation Results are forwarded to the Plan Calibration Activities function to aid in the planning of calibration maneuvers or calibration coefficient updates.

3.4.4.8 Plan Calibration Activities

The Plan Calibration Activities function uses the Evaluation Results to determine if it is necessary to update the Science Calibration Coefficients used in producing the science products, or if another calibration activity (e.g. maneuver or deploying a calibration door etc.) is necessary to further characterize the data. If necessary, a request to retrieve calibration data (Cal Data Request) from the Mission Storage is generated and the Calibration RDRs are processed upon availability from the mission storage.

Update Cal Coeffs Information is provided to the Generate Processing Coefficients function when it is determined that a new Calibration Coefficients file(s) should be generated for science processing use. If some calibration activity is required, a Cal Activity Request is provided to the C3S Manage Mission function, where the activity is planned and coordinated for the mission.

Calibration Reports are routinely generated and provided to the Manage and Monitor Resources function within the SDS. These reports are combined with reports from other functions of the SDS and provided to the C3S Manage Mission.

Direction for calibration processing is received from the SDS Manage and Monitor Resources function.

3.4.4.9 Generate Processing Coefficients

Generate Processing Coeffs accepts Update Cal Coeffs Information from the Plan Calibration Activities function. This includes information on what type of update to the cal coefficients are needed (partial or full), time frames for the applicable updates, etc.

The application calibration coefficients, which are in the Char Cal Statistics store, are used as a basis for science calibration. Calibration and characterization results available in the Char Cal Statistics store and these application coefficients are integrated into an optimal estimate of radiometric and geometric calibrations to be used in the science algorithms. New Science Cal Coefficients are generated and provided to the Produce Level 1B Products function for use in the production processing and placement in the mission storage. The data are also provided to the Format Data and Distribute function for subsequent delivery to the IDPS and to the ADS for distribution to the users.

3.4.5 Manage Mission Storage

The SDS provides storage capacity for the life of the NPP mission. This facilitates the reprocessing of the mission data based on NASA-sponsored science algorithms or calibration knowledge. The mission storage also provides services to the NPP science team to expedite data delivery to the processes providing the NASA-sponsored science products. The Manage Mission Storage function receives Mission Storage Products from the Format and distribute Data function and the Ingest RDRs function. These products consist of the validated RDRs, validated ancillary data, Level 1B data products, science calibration coefficient file(s), CDRs and the processed calibration data.

The science team responsible for the production of select higher level science products also has the capability to submit Mission Storage Queries to ascertain the contents of the mission storage. Mission Storage Responses are provided to answer the requests. This response can be answers to queries on the mission storage database, or data retrieved from the storage and transferred to the science team member.

In the case of reprocessing, Staging Requests are accepted from the Produce Level 1B Products function. The Manage Mission Storage function reacts to the staging request by retrieving the data from the mission storage and providing the Staged Data back to the Produce Level 1B Products function for continued processing.

Calibration RDRs can be retrieved from the Mission Storage for Calibration Processing based on Cal Data Requests received from the Process Calibration Data function.

3.4.6 Format Data and Distribute

The Format Data and Distribute function properly formats the Mission Storage Products for placement into the internal SDS mission storage. These products include the science calibration coefficient file(s), the processed calibration data and the Level 1B Data Package. This function also provides the mechanisms to format and distribute various products to the ADS for subsequent archive and distribution to the end users. These products include the Science Cal Coefficients Files, Formatted Level1B Data, and Formatted Climate Data.

In addition, this process provides the science team with the Formatted Level1B data to be used in the selected higher level processing. The science team processes these data and provides the Climate Data back to this function for formatting and distribution to the ADS.

Format and Distribution Status is gathered and provided to the Manage and Monitor Resources function.

3.4.7 Produce Climate Data Records

The Produce Climate Data Records (via AO) function provides the capability for the selected science team to produce higher level science quality climate research products. The Formatted Level1B Data are processed by the science teams either at their facility or as part of the SDS. For those products produced at the science team facility, there is an option to provide the Climate Products directly to the community through their own services. As an alternative, the Climate Data can be forwarded to the Format Data and Distribute function within the SDS for formatting and forwarding to the ADS, where the community can then access the climate data products.

Climate Data Records may also be generated directly from the EDRs (e.g. weekly, monthly, yearly). EDRs will be retrieved from the ADS and used to generate CDRs. The science team may submit an AO User Reprocessing Request to the Manage and Monitor Resources function for the reprocessing of individual Level 1B products which may contain an anomaly and for improved science content.

Mission Guidance is provided to coordinate the reprocessing of the entire mission storage when better quality algorithms or coefficients warrant.

3.5 ARCHIVE AND DISTRIBUTION SEGMENT

The ADS receives RDRs, SDRs, and EDRs from the IDPS, and Level 1B and higher level products from the SDS. These data are archived and made available for distribution to the user communities. Associated metadata and calibration processing parameters are archived along with the data.

The ADS provides the interface for the user community to search and browse the archive and order data products. Data products are provided to the user based on user requests. The ADS also provides the billing and accounting services necessary to fulfill these orders.

In summary, the ADS provides the following functions:

- Ingests RDRs, SDRs, and EDRs from the IDPS
- Ingests Level 1B and higher level products from the SDS
- Ingest of Ancillary and Calibration Data from IDPS and SDS
- Manages the NPP archive
- Services User Requests
- Processes and Ships User orders
- Handles the order billing and accounting
- Generates production reports.

The ADS DFD is depicted in Figure 3-20.

Title:
(ADS_DFD2a.eps)
Creator:
Adobe Illustrator(R) 8.0
Preview:
This EPS picture was not saved
with a preview included in it.
Comment:
This EPS picture will print to a
PostScript printer, but not to
other types of printers.

Figure 3-20. Archive and Distribution Segment DFD

3.5.1 Ingest Data for Archive

The Ingest Data function receives data from the IDPS and the SDS. Formatted Level 1B Data, Formatted Climate Data, Validated Ancillary Data, and Science Cal Coefficients Files are retrieved from the SDS and validated prior to insertion into the archive. The validation is to verify that the data are consistent with received metadata and that the data files are complete. Validated Data is provided to the Manage Archive function for insertion into the archive and subsequent distribution to the user community.

RDRs SDRs EDRs and Application Processing Cal Coefficients are retrieved from the IDPS and a similar validation is performed on these data before insertion into the archive.

Application Products may be received from the external Application Processing Systems. These data are validated and provided to the Manage Archive function.

Xfer Coord is provided between the Ingest Data function and the IDPS and SDS to insure that the data are ingested and archived successfully.

3.5.2 Manage Archive

The Manage Archive function provides all the functionality to manage, store, and retrieve data from the NPP archive. The function receives Validated Data from the Ingest Data for Archive function. The Manage Archive function places the data into the archive.

The Manage Archive function also provides the capability to accept Validated Queries to search the contents of the archive and provides User Query Response back to the Service User Requests function.

Archived Data is provided to the Process Orders function to fulfill user orders.

Archive Status is provided to the Generate Reports function for inclusion into the ADS production reports. This status includes information on the amount of data in the archive, performance of the archive and archive retrieval functions, and statistics on user query and data retrieval requests.

3.5.3 Service User Requests

This function provides the interface between the user community and the archive and ordering functions. Queries are accepted from users and Validated Queries are passed to the Manage Archive function. User Query Response is received and the Query Response is displayed to the End User.

Product Requests are received from the User and validated. Validation includes such things as validating that this user is a registered user, that the user has an established account that is up-to-date, and that the order is for a valid data product. Order Validation Information is retrieved from the Handle Order Accounting function to provide some of this validation.

Order Status information is provided from the Process Orders function to provide a current status of user product requests for display to users based on queries for this information.

3.5.4 Process Orders

The Process Orders function accepts Validated Orders and provides Order Notification to the Handle Order Accounting function so that the tracking process is started. Payment Notification is provided upon verification of a current account or to indicate pre-processed billing is complete. This must be completed prior to fulfilling the order. After payment notification is received, the Archive Data Request is sent to the Manage Archive requesting the appropriate data to process the user request. The Archive Data is returned to the Process Order function from the Manage Archive. The Process Order function places the data on the appropriate media (electronic or hard media) and provide Order Notification to the Handle Order Accounting function so that order tracking can be updated. Order Status is also provided to the Service User Requests function to enable users to track status of their orders. The Processed Order is passed to the Ship Products function to complete the order. Shipping Notification is provided from the Ship Products function identifying the user request has been completed and shipped/sent.

3.5.5 Handle Order Accounting

Order Notifications are received from the Process Orders function to indicate that a valid order has been received. This initiates the Billing and Payment process ensuring a valid user account or pre-payment has been received. Once payment has been received, a Payment Notification is provided to the Process Orders function so that the order can be fulfilled. A Shipping Notification is received to indicate that the product has been shipped and records are updated accordingly. This function also provides the means to register users.

Order Validation Information is exchanged with the Service User Requests function to assist in the up front order validation functions.

Accounting Status is provided to the Generate Reports function. This status will include information on outstanding balances, statistics on orders in progress, and statistics on order shipped.

3.5.6 Generate Reports

The Generate Reports function provides the production reports for the ADS that are provided to the C3 Manage Mission function. These reports will include information on the performance of the archive, the performance of fulfilling orders, and information on numbers of orders processed, and user account information.

3.5.7 Ship Products

Processed Order is received and the shipping of the Products is performed. This could be electronic or hard media shipment. Shipping Letters are generated as appropriate. Once the data has been shipped, a Shipping Notification is provided to both the Handle Order Accounting and the Process Orders functions.

3.6 LAUNCH SERVICES SEGMENT

The LSS includes the following:

- The launch vehicle and its associated facilities, support equipment, and services required to insert the NPP satellite into the proper mission orbit.

- The launch site payload processing facilities required to house the satellite and its ground support equipment at the launch site prior to the launch.

- Air Force Western Range support for the launch vehicle and the satellite.

3.6.1 Launch Vehicle

The Launch Service for the NPP satellite is to be procured by the Expendable Launch Vehicle (ELV) Program Office at the Kennedy Space Center (KSC) under the terms and conditions of the new NASA Launch Services (NLS) contract awarded in 2000. KSC procures the NPP launch service in mid-2003 as an Indefinite Delivery/Indefinite Quantity (IDIQ) task order under the NLS contract. The LV currently available today that most closely meets NPP mission requirements is the two-stage Boeing Delta II 7320 using a 9.5-foot payload fairing.

The selected LV is to be launched from the Western Range at the Vandenberg Air Force Base (VAFB) located near Lompoc, California. The satellite is transported to the launch complex and mechanically/electrically mated to the LV by the launch service contractor approximately two weeks prior to the launch.

3.6.2 Launch Support Aerospace Ground Equipment

The Launch Support AGE is all mechanical, electrical, communications, propulsion, ground handling, and monitoring equipment required to provide launch complex services for the NPP satellite launch. The majority of this AGE is required to support the LV at the launch complex and does not interface with the NPP satellite. Typical Launch Support AGE which may be required for the NPP satellite include the following:

- Electrical cabling from the satellite (via the LV umbilical) to the launch complex blockhouse for connection to satellite AGE to support pre-launch power and commands from the satellite AGE to the satellite and hard-line telemetry from the satellite to the satellite AGE. The satellite AGE is typically in the launch complex blockhouse or an adjacent building and is connected to the satellite checkout equipment located in the payload processing facility using VAFB fiber optic landlines.

- Radio Frequency (RF) communications interface equipment to provide for command and telemetry links between the LV service tower and the payload processing facility while the satellite is mated to the LV. This communications equipment typically interfaces to satellite antennas using RF couplers provided by the satellite project.

- Handling equipment for transporting the satellite to the launch complex, erection of the satellite onto the LV, mating the satellite to the LV, and installation of the payload fairing on the LV.

- Work stands to provide personnel access to the satellite prior to payload fairing installation. Work stands to provide limited access to the satellite through doors in the payload fairing after installation of the fairing.

- Launch complex equipment to provide T-0 gaseous nitrogen purge, conditioned payload fairing air, and/or T-0 battery cooling air conditioning via LV umbilicals.

- Launch complex equipment to provide an interface for satellite project-provided nitrogen purge and/or battery cooling equipment to be located at the launch complex.

- Voice and video links between the launch complex and the payload processing facility.

3.6.3 Payload Processing Facilities

The KSC ELV Program Office assigns the NPP satellite to a payload processing facility (PPF) located at VAFB. The ELV Program Office maintains a resident office at VAFB to support payload projects. After a PPF is assigned to NPP, KSC and the NPP Project determines all PPF products and services required to support the NPP mission from delivery of the satellite to VAFB until after the launch. These requirements are to be included in the KSC Launch Site Support Plan (LSSP).

Spacecraft are typically delivered to VAFB two to three months before launch. The NPP satellite can be transported directly to the PPF using ground transportation or flown to the VAFB airfield and moved from the airfield to the PPF via ground transportation. Final integration and test activities required before launch are performed at the PPF. Satellite checkout equipment is typically linked to the remote mission operations center (MOC) via voice and data lines. The satellite checkout equipment is typically linked to the launch complex with voice and data links, and video and RF links can be established if required. The MOC can then exchange telemetry and commands with the satellite through the checkout equipment in the PPF while the satellite is in the PPF or at the launch complex.

The launch service contractor encapsulates the satellite in ground transportation AGE at the PPF approximately two weeks prior to the launch. The AGE is purged with dry nitrogen gas for humidity control during transport to the launch complex. The launch service contractor is responsible for transport of the satellite to the launch complex, erection on the service tower, and mechanical/electrical mate with the LV.

3.6.4 Western Range Support

The Air Force Western Range (WR) at VAFB provides products and services to the NPP such as security and escort services, communication and data lines, photography and video support, laboratory services, RF protection, and weather forecasting. The WR is also responsible for overall range safety. WR support for NPP is defined in a Program

Requirements Document (PRD) jointly developed by the project and KSC. The project is required to submit a Missile System Pre-Launch Safety Package (MSPSP) to the WR. The MSPSP provides an assessment of the risks involved with the satellite transportation, handling, integration and test, and mate to the LV. It also includes a description of the NPP flight hardware, AGE, test procedures, and launch complex operations and testing.

4.0 OPERATIONS CONCEPT

NPP operations are described within the context of four modes:

- Pre-Launch/Launch Readiness
- Launch and Early Checkout
- Nominal Operations
- Non-Nominal Operations.

The NPP nominal and non-nominal operations are described by a series of scenarios developed within the framework of the System Concept defined in Section 3 of this document. These scenarios provide an overview of the major threads through the System Concept to describe how major activities are accomplished. The set of scenarios help in understanding how the System behaves and serves as a tool to aid in verifying the completeness of the System Concept. The scenarios do not portray every possible situation that may be encountered during operations but serve as a basis for further operations planning.

Each scenario is aimed at achieving a specific objective, given a set of assumptions. Together, the objective and assumptions set the stage for the scenario. Assumptions include any pre-requisite activities that help set the stage before the scenario begins. The scenario is illustrated by a diagram depicting the sequence of data flows between functions that were introduced in the System Concept. Each data flow is numbered to show the order in which the activity occurs within the scenario. A letter immediately following a sequence number indicates more than one activity is occurring concurrently. While the sequence numbers are included to aid in following the scenario, there may exist more than one valid sequence of activities to accomplish a scenario objective.

A scenario description is included with each diagram to provide a narrative of the major activities.

4.1 OPERATIONS OVERVIEW

The operations associated with the NPP fall into four operational modes. These modes include: Pre-Launch/Launch Readiness, Launch and Early Checkout, Nominal Operations, and Non-Nominal Operations.

The Pre-Launch/Launch Readiness mode includes instrument integration and test, spacecraft integration and test, and space / ground testing activities all as part of the pre-launch development, test, and operations preparation leading up to launch. Heavy emphasis is placed on the final phase of this mode including the shipment of the satellite to the launch facility, integration of the satellite with the launch vehicle, and final testing. Pre-launch instrument performance verification is also part of this mode that affords the opportunity to characterize and calibrate the instruments prior to and during integration activities with the spacecraft. End-to-end system level testing is performed as an incremental process to ensure interface, functional, and performance requirements are achieved. This mode runs throughout the course of instrument, spacecraft, and ground system development and integration through the final phase of launch readiness.

The Launch and Early Checkout is comprised of the launch, spacecraft and instrument activation, and early validation. The launch includes the final countdown, liftoff, ascent and separation of the satellite from the LV. Following separation from the LV, the satellite executes a pre-defined activation sequence. A flight operations team, managed by the IPO, and the satellite engineering support team jointly execute/monitor the satellite operations activities under the supervision of the NASA management team. After initial verification of a healthy satellite, the instrument activation sequences are performed. In addition to the space segment activities, a similar function occurs with the early validation of the ground-based systems. This serves to support the on-orbit calibration activities of the instruments while also validating the data processing algorithms and calibration tables. Initial tuning of the instruments is performed during this mode, prior to entering the nominal operations mode. The satellite activation sequence runs from the time of launch through approximately L+90 days followed by approximately 180 days for the early validation. Management responsibilities transition from NASA to IPO after the satellite activation is successfully complete.

The Nominal Operations mode represents the routine mission operations where telemetry data are acquired and routine operational and science data processing are performed. As part of the nominal operations, periodic calibration maneuvers are expected, and updates to the calibration tables are necessary. The data records are provided to the Centrals for use in their weather modeling and to the SDS for NASA unique science processing. The IDPS data records and SDS data products are also provided to the archive where the data are made available for distribution to users.

The Non-Nominal Operations mode describes any out of the ordinary mission activities. This may include unusual conditions associated with any segment of the NPP mission. While this mode deals with unexpected occurrences, non-nominal scenarios can be anticipated and thus, to some degree, planned.

4.2 OPERATIONS SCENARIO MODES

4.2.1 Pre-Launch/Launch Readiness

Early pre-launch activities include the integration of the space and ground segments. During these integration activities, interface and compatibility tests are performed. Simulated and live instrument data are utilized to verify interfaces and functional requirements in an operational mode that resembles on-orbit handling to the extent practical.

The pre-launch phase continues with the arrival of the NPP satellite at its assigned payload processing facility (PPF) at Vandenberg Air Force Base (VAFB). After unpacking and initial visual and electrical checkout of the satellite are completed, final preparations for launch begin in the PPF. Aerospace ground equipment (AGE) is connected to the satellite for the final integration and test activities. The remote operations control center may be used to command the satellite and monitor telemetry through the spacecraft AGE while it is in the PPF. Satellite fueling, if required, is performed prior to transport to the launch complex.

The launch service contractor encapsulates the satellite in ground handling AGE when it is ready for transport to the launch complex. The handling canister is purged with dry gaseous nitrogen during the trip to the launch complex for humidity control. The launch service contractor transports the satellite to the launch complex, erects the canister/

satellite on the service tower, mechanically/electrically mates the satellite to the launch vehicle (LV), and removes the canister and ground handling AGE.

After the satellite is mated to the launch vehicle, a T-0 gaseous nitrogen purge and T-0 battery cooling air conditioning system is connected to the satellite. The electrical harnesses from the satellite to the satellite AGE in the blockhouse via the LV umbilical and launch complex cabling are checked out. Satellite AGE provides external power to the satellite after these electrical connections are verified. Voice, data, video, and radio frequency (RF) links between the launch complex and the PPF are verified. Stand-alone testing and testing integrated with LV test procedures on the satellite begin after all the electrical connections and communications links are verified. The command/telemetry communications interface between the operations control center and the satellite via the PPF and landlines from the PPF to the launch complex are verified. The C3S conducts end-to-end command and telemetry testing with the satellite while it is on the LV after these communications interfaces are verified.

NPP launch management personnel are required to attend launch and flight readiness reviews, and participate in a launch countdown rehearsal conducted by the NASA/KSC launch team. The launch countdown is conducted by the launch service contractor launch team at the VAFB Remote Launch Control Center (RLCC), physically located several miles from the launch complex. The NASA/KSC launch management team staffs the NASA Mission Director Center (MDC) located in the NASA office building (Building 840) on the VAFB South Base. NPP project managers with the authority to provide a go/no go status for launch are located in the MDC during the countdown and launch. These managers have access to communications networks to coordinate with NPP operations and engineering teams at the PPF, C3S, and spacecraft contractor facility during the countdown.

4.2.2 Launch and Early Checkout

The launch phase begins with the final countdown and includes liftoff, ascent, and separation of the satellite in the proper orbit at the desired attitude. The C3S monitors satellite systems during the countdown to verify the health and launch configuration for all systems. The satellite is commanded to final launch configuration and switched to internal power a few minutes prior to liftoff. Typically this is to a low power or quiescent state.

The countdown proceeds until liftoff if the NASA/KSC, launch service contractor, NPP Project, and USAF Western Range (WR) launch teams all agree that there are no impediments to launch. Reception of LV telemetry via ground stations or instrumented aircraft during all powered flight portions of the launch and ascent are required. No satellite telemetry is transmitted during launch and ascent. The LV will inject the satellite into an approximately 824 km polar sun-synchronous orbit with a 10:30 AM descending nodal crossing time. The launch phase ends with the separation of the satellite from the LV at the pre-determined attitude. LV telemetry is required via ground station or instrumented aircraft during satellite separation. Satellite activation is initiated through a breakwire signal generated when the satellite wire harness is separated from the LV umbilical or via a signal generated by satellite separation switches at separation. The launch service contractor provides the C3S with a state vector at satellite separation to provide acquisition assistance for early tracking coverage.

The satellite performs a pre-programmed activation sequence after separation from the LV that includes early deployment of solar arrays and maneuvering of the satellite to turn the arrays toward the sun. The C3S monitors satellite status and health via telemetry received during early ground station passes. Early orbit checkout is initiated after the satellite configuration and health are verified by the C3S.

The early orbit checkout also encompasses the methodical steps to activate the satellite payload complement. Each instrument is activated based on a series of steps following outgassing. The activation steps include:

- power on of instrument control electronics, housekeeping data, and receiver and channel electronics
- deployment of antenna/doors
- power on of scan motors.

As part of instrument checkout following activation, baseline calibration assessments are conducted. Any calibration maneuvers, such as cold space and/or lunar views, are executed to obtain baseline data for solar diffuser evaluation, stability assessment, and boresight alignment. Based on these initial calibration data, instrument tuning is performed.

With instrument activation, the IDPS begins to receive the RDRs routed from the space to ground segments. As part of the early validation, instrument data, in the form of RDRs, are processed through the IDPS algorithms, and subsequently the SDS. The quality of the data and data records generated are assessed and used in further validating the instrument, as well as validating and refining the processing algorithms/software and/or the calibration tables. A strategy to declare the data valid, thereby releasable, is to be determined. This also denotes the transition from the checkout and early validation activities to the nominal operations mode.

4.2.3 Nominal Operations

The nominal operations includes the routine satellite and data handling activities performed throughout the life of the mission following the early checkout. A representative set of operational scenarios are described in the following sub-sections. While not exhaustive, the scenarios portray an operation sequences of steps, for a specific objective, to be performed based on the functional model (the DFDs) found in Section 3.

4.2.3.1 Spacecraft Diary and Time Parameter Generation

Objective:

This scenario depicts the generation of the Spacecraft Diary and time parameters for instrument utilization.

Assumptions:

– Star navigation references have been uplinked and loaded into the Store Navigation Information function and the Reference Stars input has been received by the Determine and Control Attitude function. Figure 4-1 depicts the Spacecraft Diary and Time Parameter Generation scenarios.

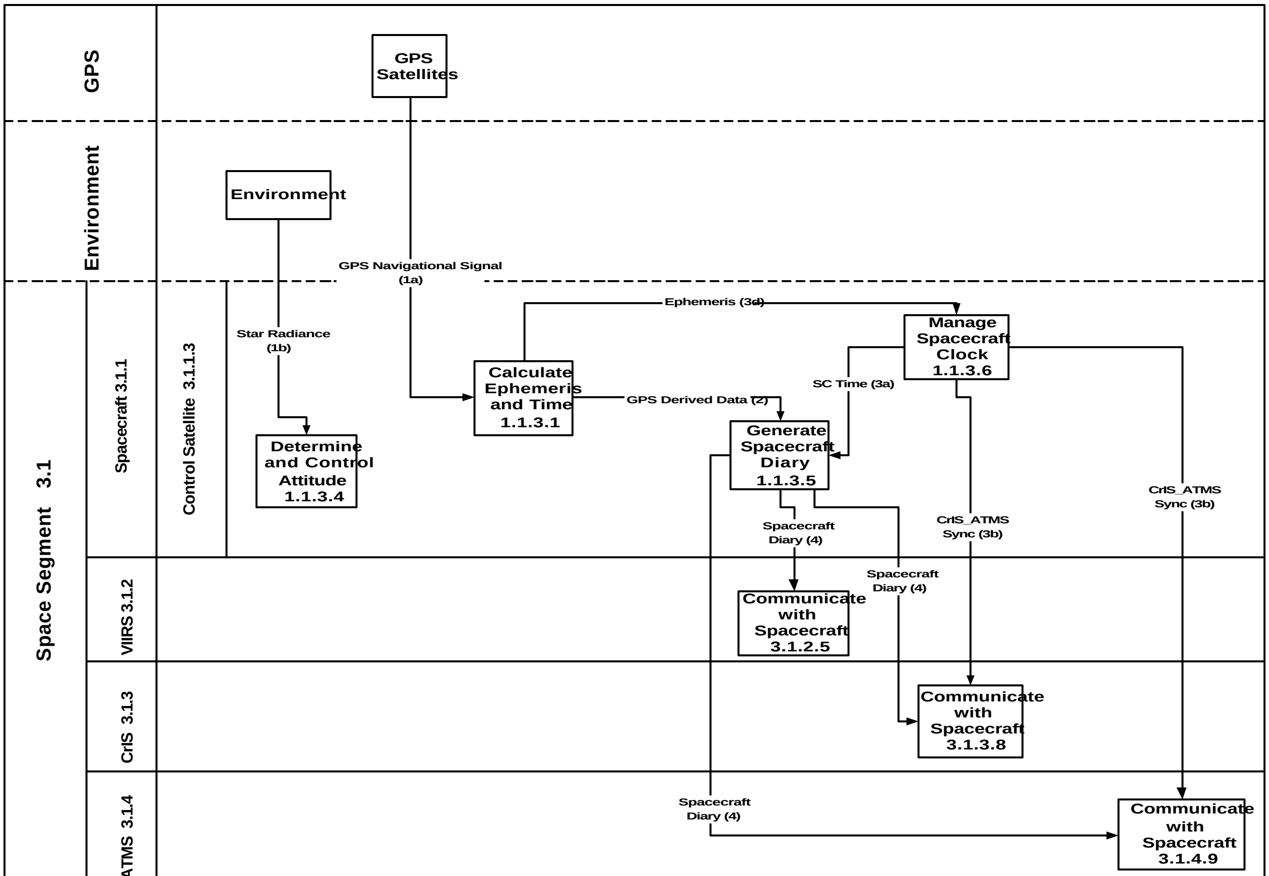

Figure 4-1 Spacecraft Diary and Time Parameter Generation 4.2.3.1

Scenario Description:

Spacecraft Diary information, SC Time and the CrIS ATMS Sync pulse must be generated in order for the instruments to acquire and format data. The GPS Navigational Signal is continuously received by the Calculate Ephemeris and Time function and used to calculate the Ephemeris and GPS Derived Time. The GPS Derived Time is used in the Manage Spacecraft Clock function to generate the CrIS ATMS Synch signal and SC Time.

Star Radiances are used to help establish spacecraft Attitude in the Determine and Control Attitude function. Attitude is combined with the Ephemeris, Spacecraft Telemetry, and SC Time to generate the Spacecraft Diary by the Generate Spacecraft Diary function. The Spacecraft Diary is sent to VIIRS, CrIS, and ATMS instruments. The CrIS ATMS Synch signal is sent to CrIS and ATMS.

4.2.3.2 Routine On-Board Data Acquisition

Objective:

The objective of this scenario (Figure 4-2a-c) is to show the sequence of events that occurs during routine on-board data acquisition. These events began with the observation of the radiances by the instruments, through packet generation and frame assembly, and subsequent data storage/transmission.

Assumptions:

- The instruments are in "Operational" mode
- IOO Instrument is not included in this scenario but is operationally similar to the other instruments
- SC Time is being sent continuously to the instruments.

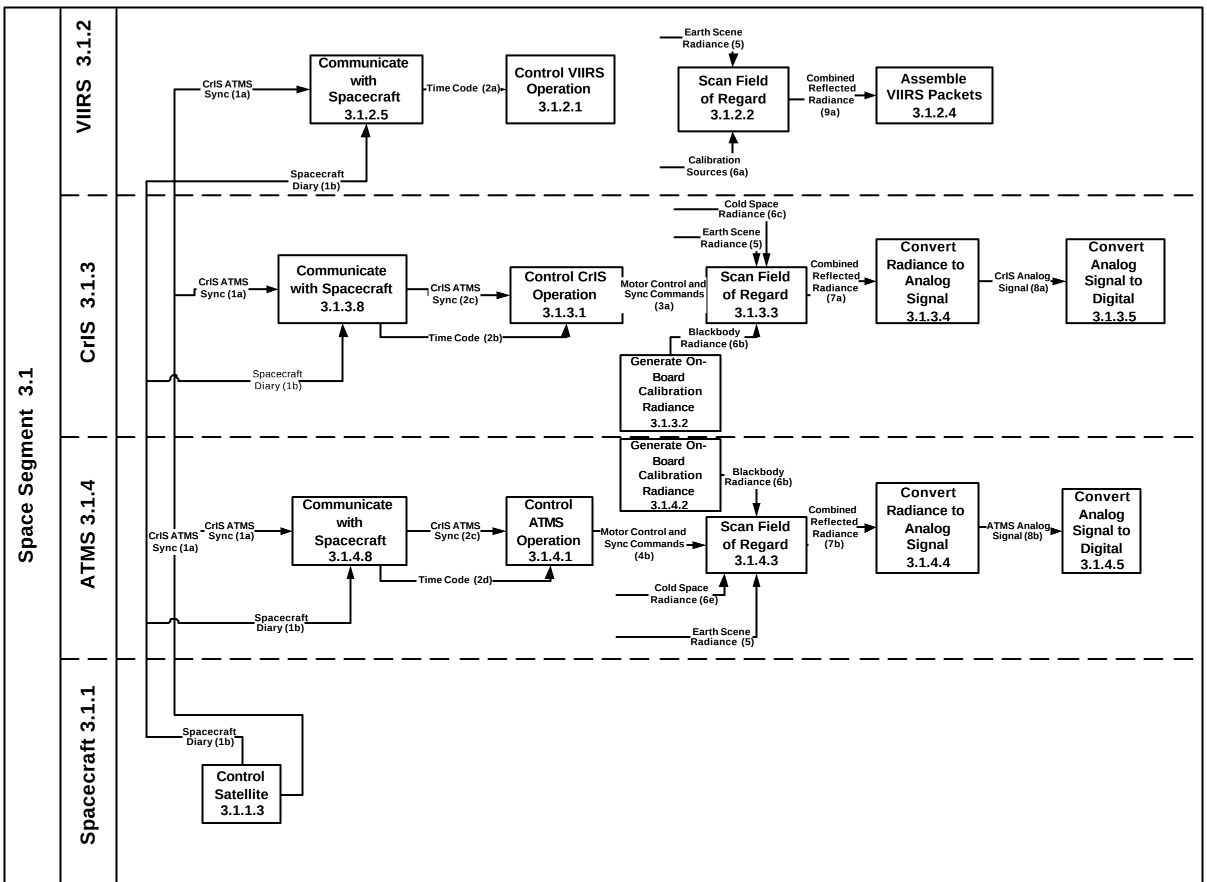

Figure 4-2a Routine On-Board Data Acquisition Scenario 4.2.3.2 (1 of 3)

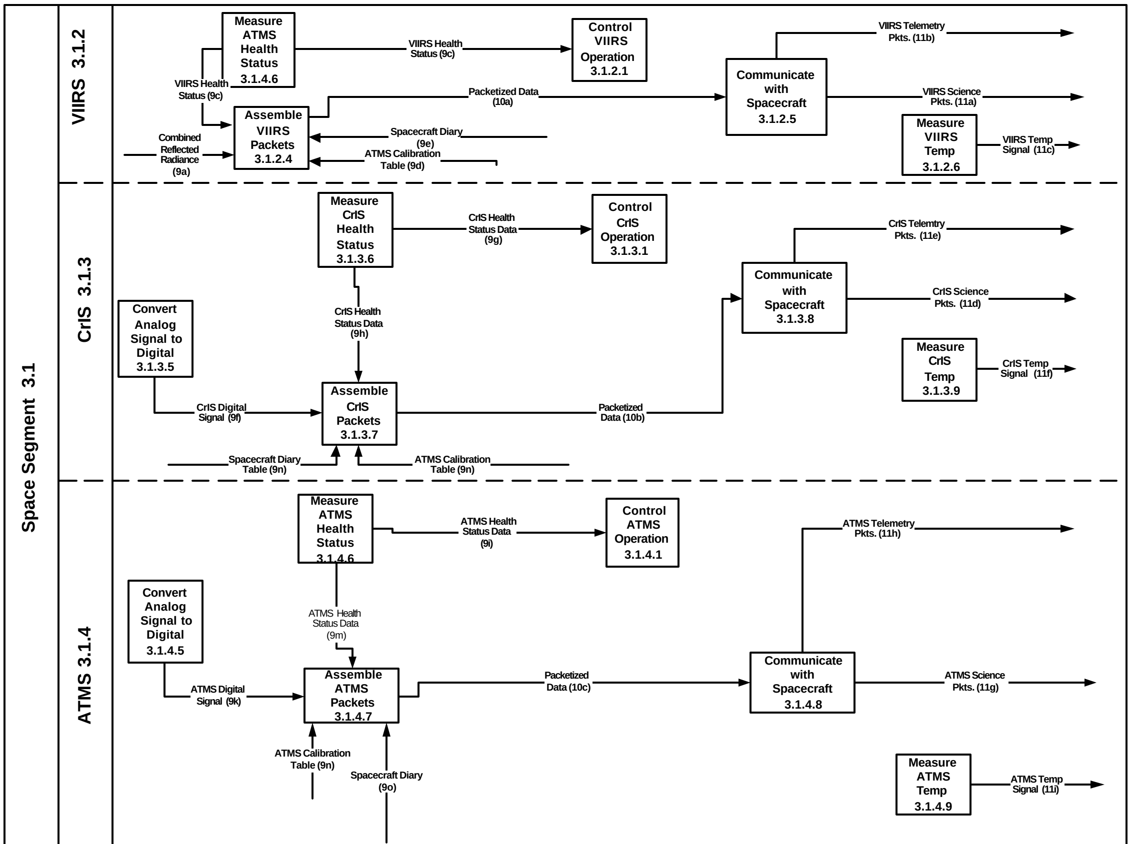

Figure 4-2b Routine On-Board Data Acquisition Scenario 4.2.3.1 (2 of 3)

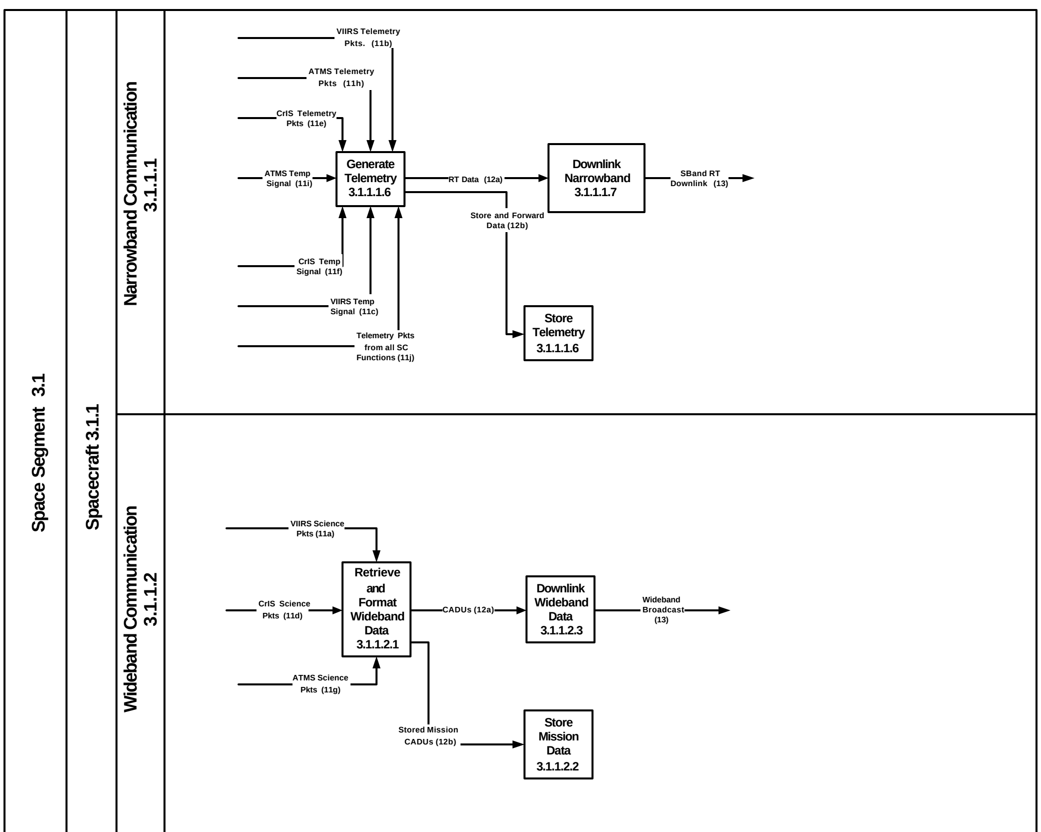

Figure 4-2c Routine On-Board Data Acquisition Scenario 4.2.3.1 (3 of 3)

Scenario Description:

The Spacecraft Diary and CrIS ATMS Sync pulse are continuously provided to the instruments (as appropriate). These are used to provide time code sequencing and, in the case of CrIS and ATMS, scan synchronization. Each instrument has a Scan Field of Regard function, which detects various radiances (e.g. Earth Scene, Cold Space, Internal Calibration). These radiances are combined and digitized within each instrument and provided to the packet assembly functions. The packet assembly functions produce individual packet streams from the digitized radiances, Spacecraft Diary and instrument Health Status Data. The Science Packet streams are forward by each instrument to the Receive and Format Wideband Data function and combined into frames. These frames (a.k.a. CADUs) are sent to the Downlink Wideband Data function to be continuously broadcasted, and to the Store Mission Data function for subsequent SMD downlink.

The instrument telemetry packets and temperature signals, containing instrument health and status data, are generated concurrently with the Science Packets and provided to the Generate Telemetry function. The Generate Telemetry function combines these heath and status packets with Telemetry Packets from all other satellite functions into frames. The frames are output as RT Data to the Downlink Narrowband function for broadcast and to the Store and Forward Telemetry function for subsequent replay to the C3S.

4.2.3.3 Build Satellite Schedule

Objective:

This scenario (Figure 4-3) depicts the coordination required to schedule a routine contact between the NPP satellite and a polar ground station.

Assumptions:

- NPP Mission Planning has verified a need to schedule a future contact with a polar ground station.

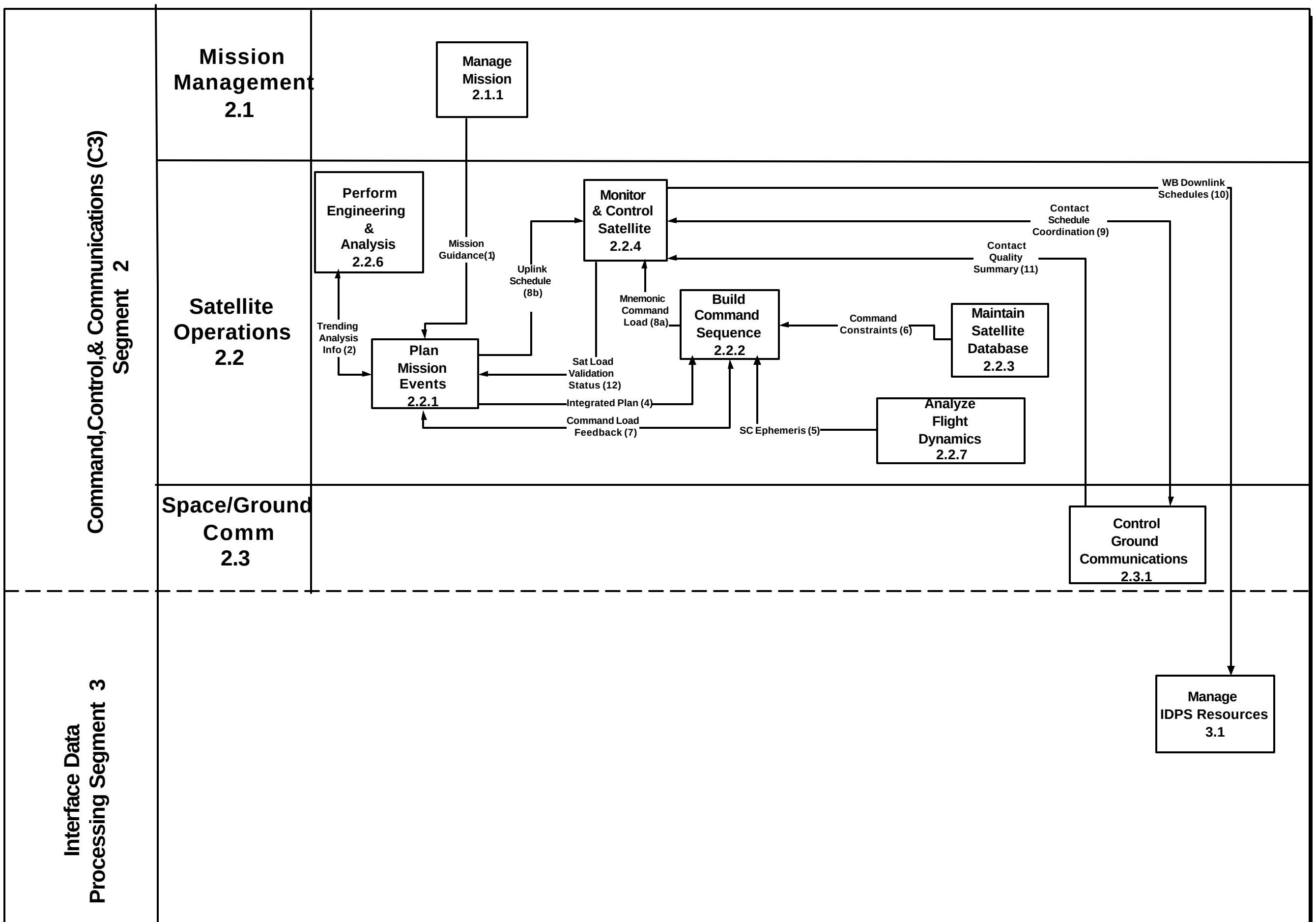

Figure 4-3 Build Satellite Schedules Scenario 4.2.3.3

Scenario Description:

Based on mission guidance from Mission Management, the Manage Satellite Operation, Mission Planning function generates an integrated plan containing the future schedule for satellite acquisitions via the polar ground stations. These schedules are produced up to three weeks in advance of the actual acquisition and are refined as the event approaches. The satellite acquisition schedule is negotiated via contact schedule coordination against conflicts with planned satellite maneuvers and planned downtimes at the receiving stations. The final results go into the integrated plan that is provided to the Build Command Sequence function. Build Command Sequence uses satellite ephemeris from the Flight Dynamics function along with command constraints from the Satellite Database to generate a mnemonic command load that is forwarded to the Monitor and Control Satellite function. Build Command Sequence also provides command load feedback to the Plan Mission Events function for the possible update of the integrated plan due to conflicts.

The WB Downlink Schedule is also provided to the IDPS to allow them to plan their resources based on upcoming satellite acquisitions.

4.2.3.4 Routine Contact with the Polar Ground Station

This scenario is divided into four separate mini-scenarios (Figure 4-4a through 4-4d) for clarity. The mini-scenarios are:

- Setup Pass
- Acquisition of Satellite Signal
- Dump Stored Mission Data
- Uplink Command Loads.

4.2.3.4.1 Setup Pass

Objective:

This scenario (Figure 4-4a) depicts the coordination that takes place immediately before a satellite acquisition session over a polar ground station.

Assumptions:

- Satellite scheduling has been successfully negotiated as depicted in the previous scenario.

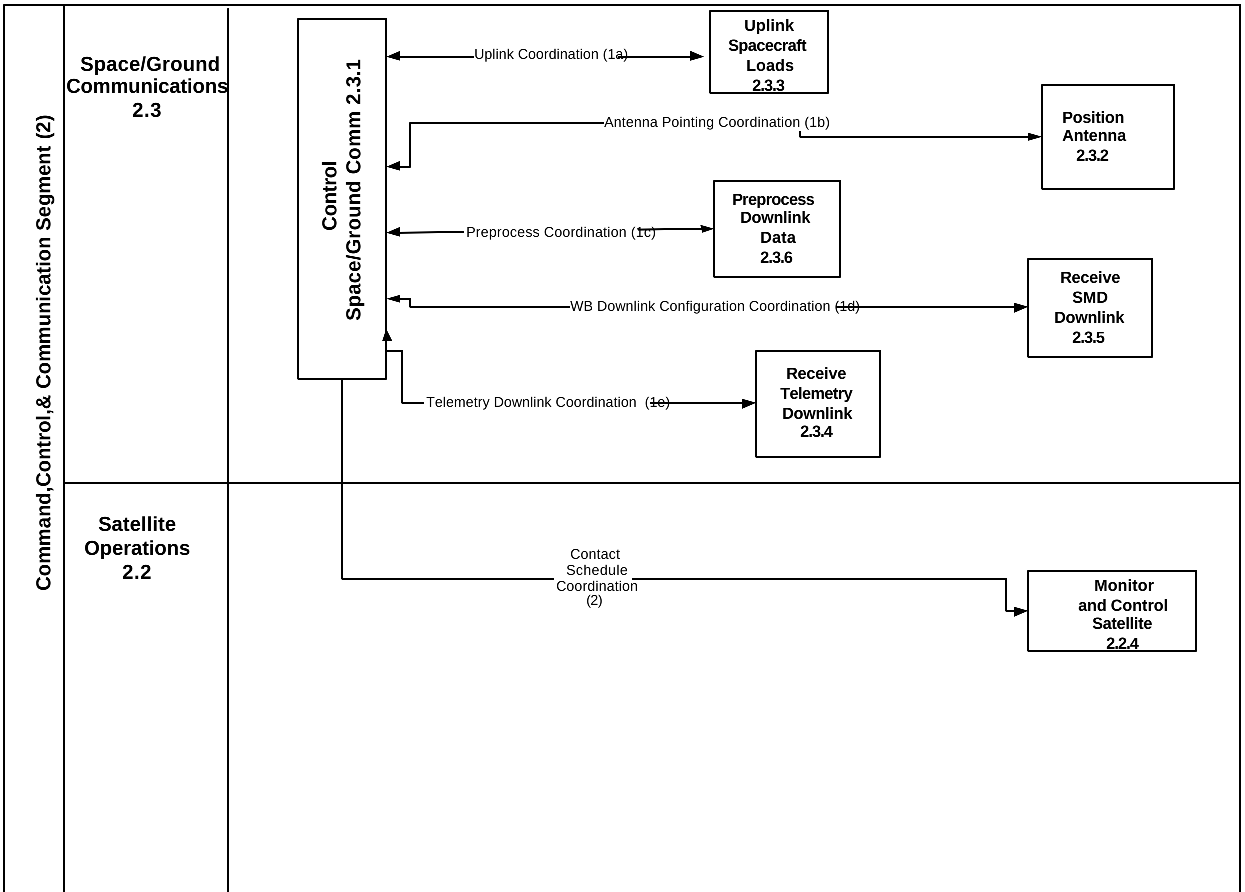

Figure 4-4a Routine Contact with Polar Ground Stations (Pass Setup)
Scenario 4.2.3.4.1

Scenario Description:

Minutes prior to a scheduled pass, the Control Space/Ground Communication function configures the Position Antenna, Uplink Spacecraft Load, Preprocess Downlink, Receive SMD downlink, and Receive Telemetry Downlink functions and checks their readiness to process the upcoming acquisition. Any failures to achieve readiness are mitigated by Control Space/Ground Communication with assistance from the Monitor and Control Satellite function (if necessary).

4.2.3.4.2 Acquisition of Satellite Signal

Objective:

In this scenario (Figure 4-4b), the coordination between C3S and the SS is outlined for handling the initial acquisition of the downlink signals as it comes over the horizon.

Assumptions:

- The satellite is transmitting realtime Sband SOH data and wideband fill CADUs.

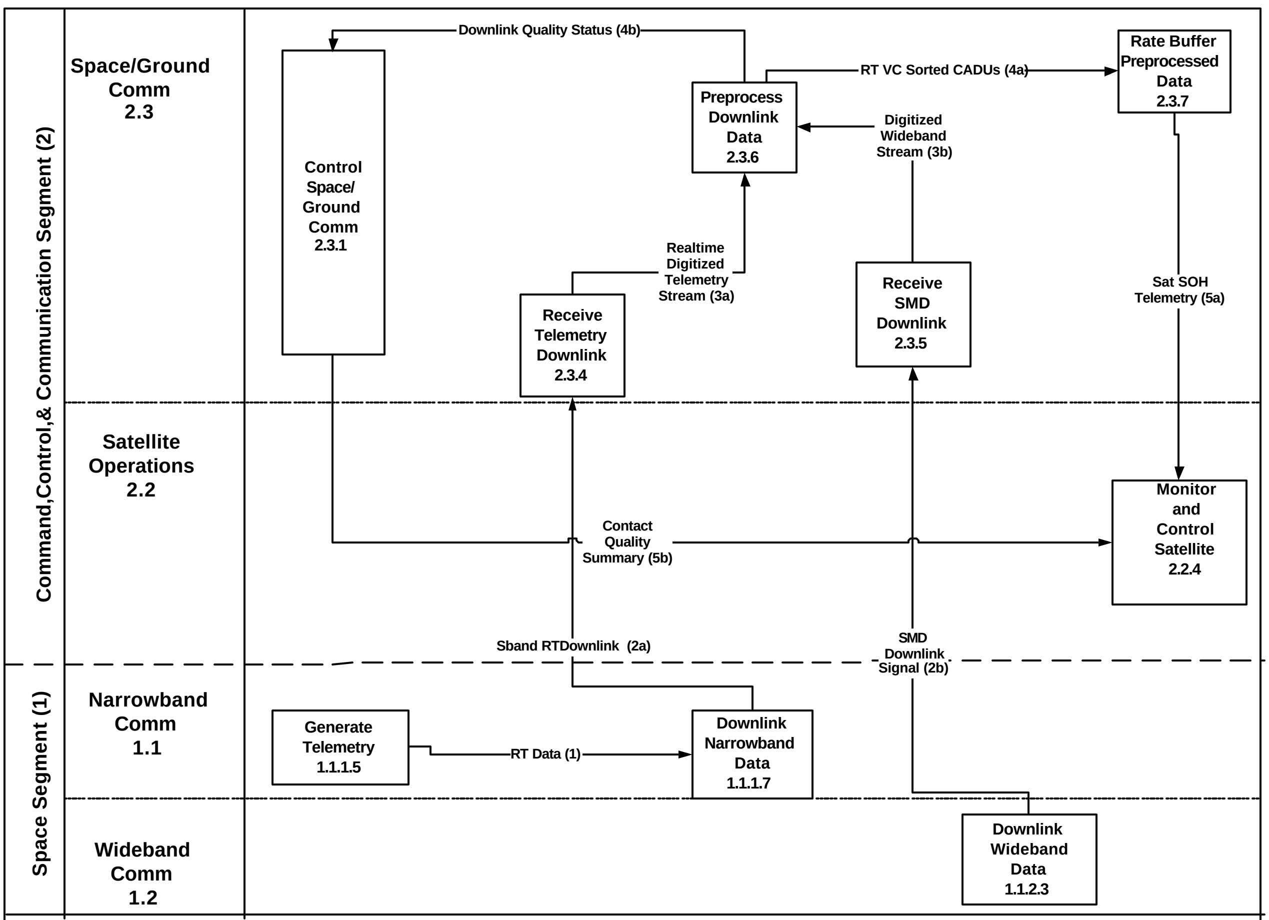

Figure 4-4b Routine Contact with Polar Ground Stations (Acquisition of Satellite Signal)
Scenario 4.2.3.4.2

Scenario Description:

The Generate Telemetry function within Narrowband Communications continuously generates RT Data that in turn, is broadcast by the Downlink Narrowband Data function as Sband RT Data. As the satellite comes into range of the scheduled Polar ground station antenna, the Receive Telemetry Downlink function within Space/Ground Communications locks onto the Sband RT Downlink. Simultaneously, the Downlink Wideband Data function begins to generate fill data that is transferred to the Receive SMD Downlink function, which embeds it into SMD Downlink Signal as a preamble.

Within Space/Ground Communications, the Receive Telemetry Downlink function takes the Sband RT downlink and decommutates and digitizes it into the realtime digitized telemetry stream for transfer to the Preprocess Downlink Data function. At the same time, the wideband fill data is digitized and also forwarded to the Preprocess Downlink Data function

The Preprocess Downlink Data function then converts the realtime digitized telemetry stream into RT VC sorted CADUs and provides them to the Rate Buffer Preprocessed Data function. In parallel, Downlink Quality Status is provided to the Control Space/Ground Communications function. The Downlink Quality Status is monitored for anomalies and subsequently provided to the Monitor and Control Satellite function in the form of a Contact Quality Summary. In addition, Satellite State of Health Telemetry is received by the Monitor and Control Satellite function from the Rate Buffer Preprocessed Data function.

4.2.3.4.3 Dump Stored Mission Data

Objective:

This scenario (Figure 4-4c) depicts the real time commanding procedure for the satellite to start dumping stored mission data. Note: This scenario does not preclude the possibility for this commanding to be performed via stored commands.

Assumptions:

- The satellite is transmitting real time Sband SOH data and wideband fill CADUs
- The satellite is in solid lock with the GS antenna
- Satellite control personnel have determined a sufficient time window to accomplish the SMD dump

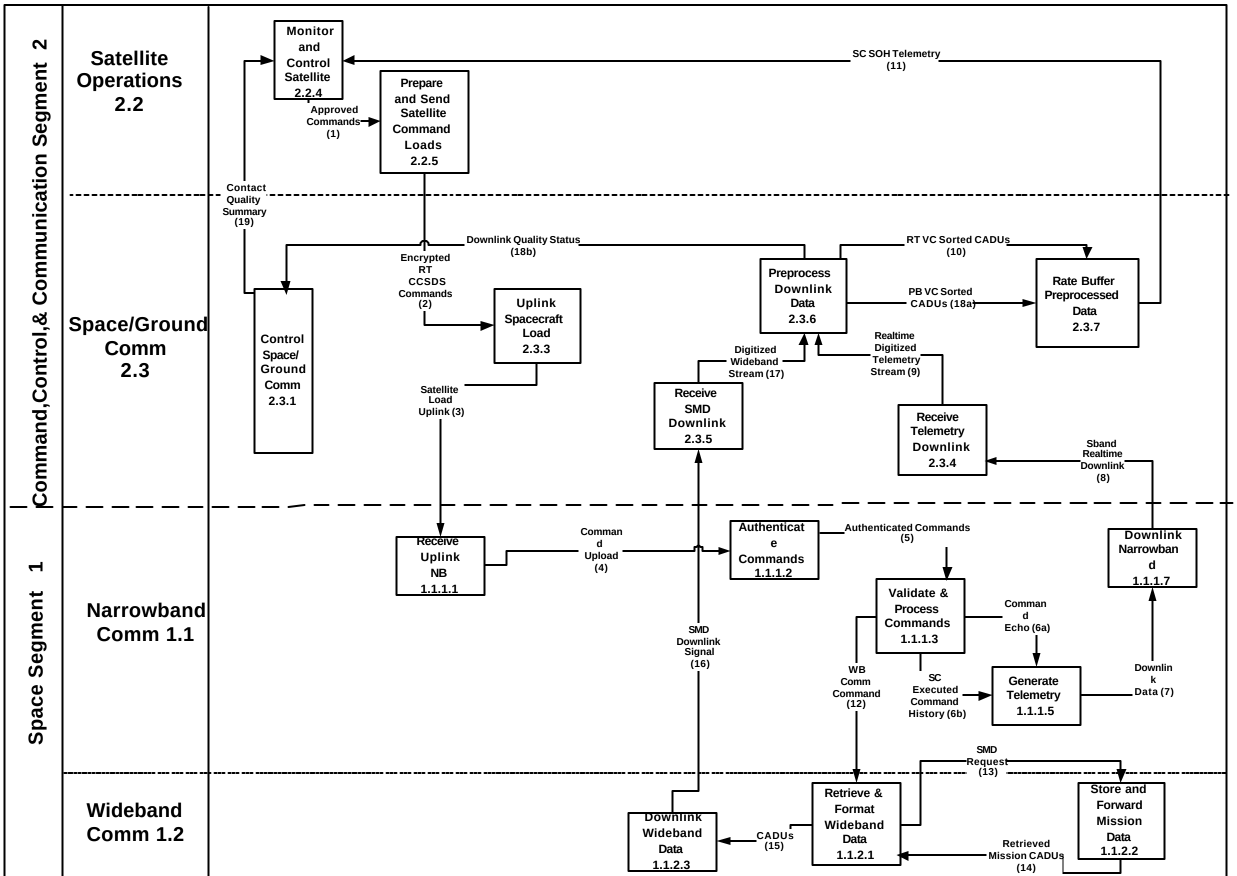

Figure 4-4c Routine Contact with Polar Ground Stations (Dump Stored Mission Data)
Scenario 4.2.3.4.3

Scenario Description:

The Monitor and Control Satellite function sends a real time command to dump the SSR. This real time command is embedded in the Approved Commands stream and transferred to the Prepare and Send Satellite Command Loads Function.

Prepare and Send Satellite Commands encapsulates and encrypts the Approved Commands and forwards it to the Uplink Spacecraft Loads function as the Encrypted RT CCSDS Commands stream. Uplink Spacecraft Loads embeds the Encrypted RT CCSDS Commands into the Satellite Load Uplink, which is received by the Receive Narrowband Uplink function onboard the satellite.

On the satellite, the Receive Narrowband Uplink function extracts the Encrypted RT CCSDS Commands from the uplinked stream and passes Command Uploads to the Authenticate Commands function. Authenticate Commands validates the received commands, generates and then forwards a command echo to the Generate Telemetry function in near real time. The Generate Telemetry function packages the command echo and the SC Executed Command History into RT Data and transfers them to the Downlink Narrowband function. Here, the Sband Realtime Downlink is modulated and downlinked to the Receive Telemetry Downlink function.

The Sband Realtime Downlink is demodulated, decoded and digitized within the Receive Telemetry Downlink function and transferred to the Preprocess Downlink Data function in the form of a realtime digitized telemetry stream. The realtime digitized telemetry stream is frame synchronized, error corrected, and sorted into virtual channels then transferred as RT VC sorted CADUs to the Rate Buffer Preprocessed Data function. The satellite state of health telemetry, which contains the command echo, and SC executed command history is transferred to the Monitor and Control Satellite function for analysis.

Concurrently, the Validate and Process Commands function in Narrowband Communication converts the authenticated commands to dump the SSR (Retrieval Commands) into WB Comm commands and transfers them to the Retrieve and Format Wideband Data function. There, a SMD dump request is sent to The Store Mission Data function and mission CADUs are returned. The Retrieve and Format Wideband Data function then forwards the wideband CADUs to the Downlink Wideband Data function. An SMD Downlink signal is generated and captured in the Receive SMD Downlink function within Space/Ground Communications. The wideband data is preprocessed into PB VC Sorted CADUs and forwarded to the Rate buffer Preprocessed data function for subsequent retrieval by IDPS.

4.2.3.4.4 Uplink Command Loads

Objective:

This scenario (Figure 4-4d) depicts the activity that uplinks a command load and assures that all commanding was done successfully. The scenario ends with ground verification of the command echo data returned from the spacecraft.

Assumptions:

- NPP Mission Planning has verified a need to update the onboard command sequence.
- The command load is already generated and validated
- The NPP satellite is currently in communications with an S-band capable station

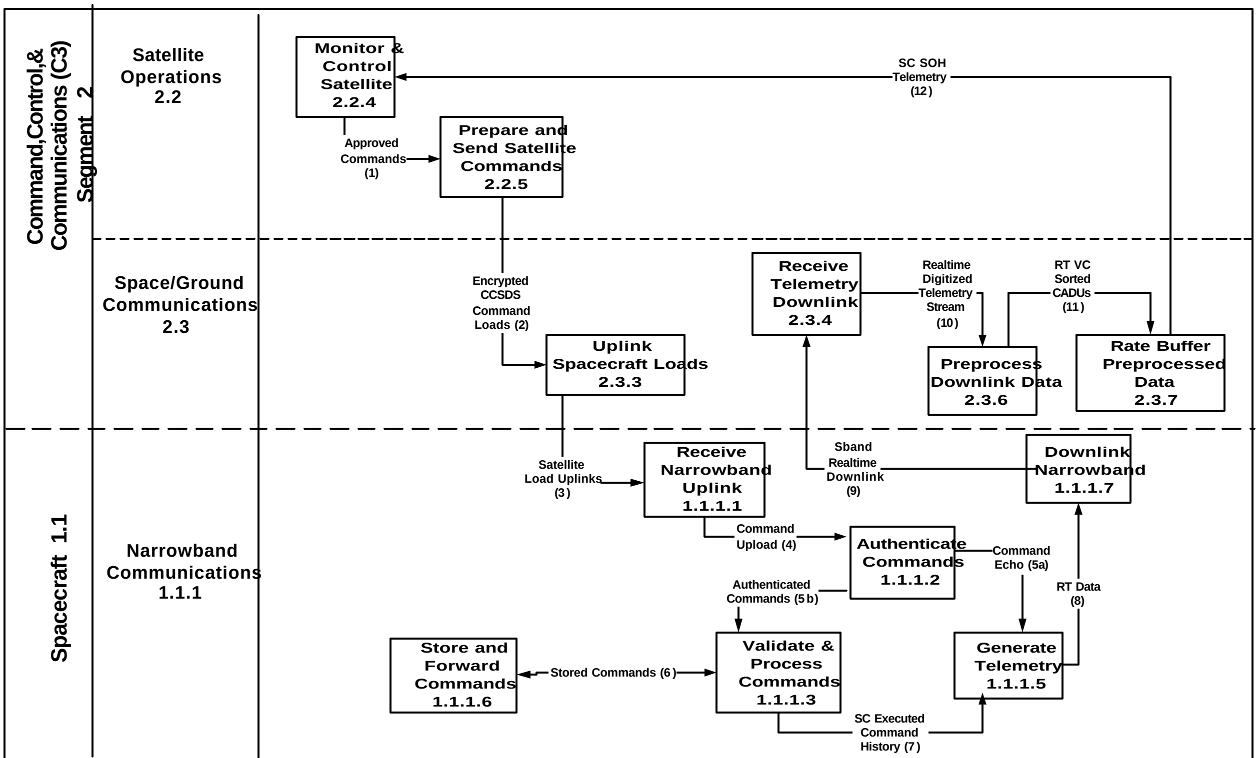

Figure 4-4d Uplink Command Loads Scenario 4.2.3.4.4

Scenario Description:

At an appropriate interval during the satellite contact with a Polar Ground Station, satellite operations personnel will decide to uplink a command load.

The Monitor and Control Satellite function verifies and approves the command load and forwards the Approved Commands to the Prepare and Send Satellite Commands function. Prepare and Send Satellite Commands embeds the Approved Commands into an Encrypted CCSDS Commands Load. The Uplink Spacecraft Loads function receives the Encrypted CCSDS Commands Load and uplinks it to the Receive Narrowband Uplink function as the Satellite Load Uplink.

On the spacecraft, the Receive Narrowband Uplink function extracts the Command Upload from the uplinked stream and passes it to the Authenticate Commands function. Authenticate Commands validates the received commands, generates and then forwards a command echo to the Generate Telemetry function in realtime. In parallel, Authenticate Commands forwards Authenticated Commands to the Validate and Process Commands function where the commands are routed to the Store and Forward Commands function while the SC executed command history is forwarded to the Generate Telemetry function for downlink.

The Generate Telemetry function packages the command echo and the SC executed command history into RT Data and transfers them to the Downlink Narrowband function.

Here, the Sband realtime downlink is modulated and downlinked to the Receive Telemetry Downlink function within C3S Space/Ground Communications area.

The Sband realtime downlink is demodulated, decoded and digitized within the Receive Telemetry Downlink function and transferred to the Preprocess Downlink Data function in the form of a realtime digitized telemetry stream. The realtime digitized telemetry stream is frame synchronized, error corrected, and sorted into virtual channels then transferred as RT VC sorted CADUs to the Rate Buffer Preprocessed Data function. Here, the SC SOH telemetry, which contains the command echo, and SC executed command history is transferred to the Monitor and Control Satellite function for analysis. The command echo and spacecraft executed command history data is analyzed to assure that the command load was successfully transferred to the satellite.

4.2.3.5 Operational Product Handling

Objective:

This scenario (Figure 4-5) explains steps for receiving, processing and archiving operational products.

Assumptions:

- An acquisition session has occurred and the C3S is ready to transfer rate buffered CADUs to IDPS
- At some earlier time, both the Application Processing Systems within the Centrals and SDS provided IDPS with subscriptions to products
- Centrals (and SDS) have the application processing cal coefficients.

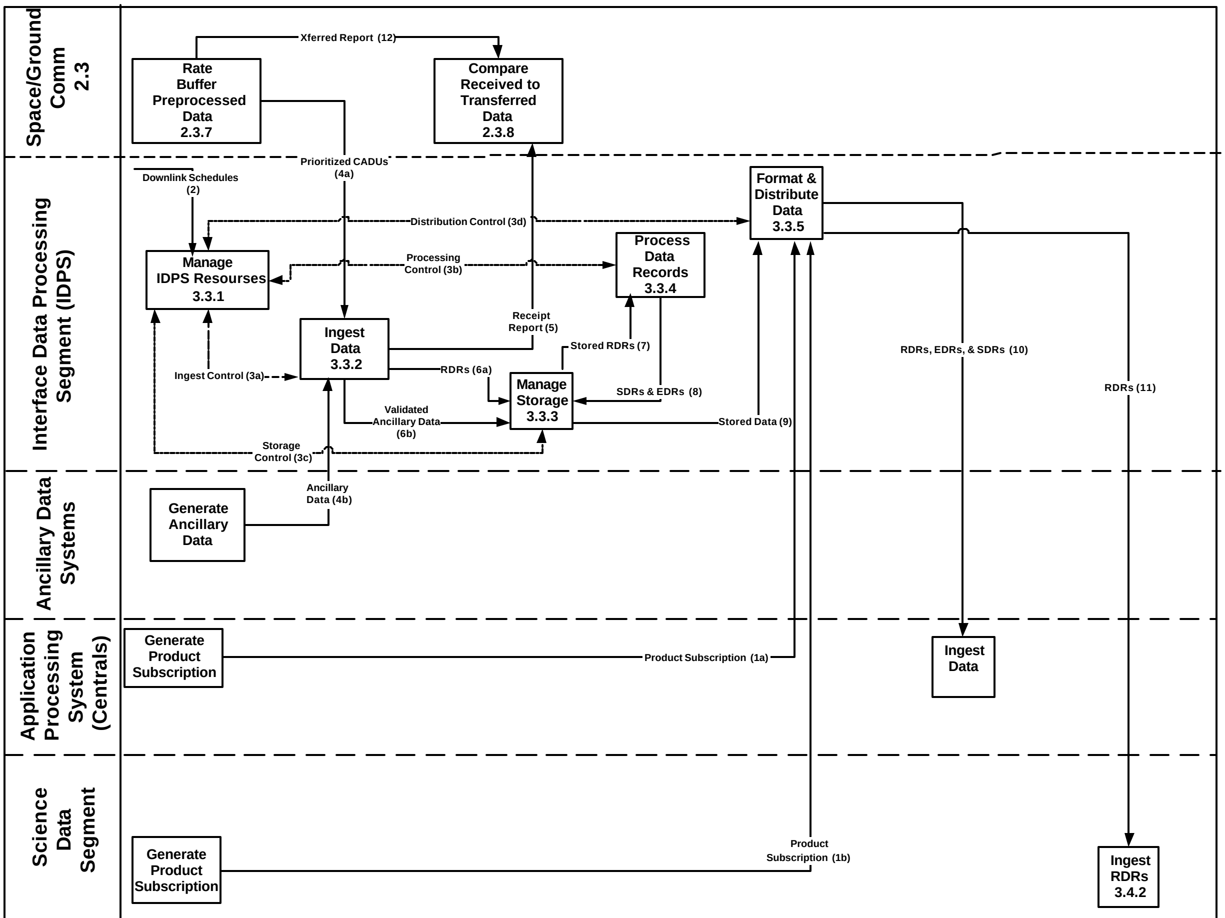

Figure 4-5 Operational Product Handling Scenario 4.2.3.5

Scenario Description:

The Manage IDPS function receives downlink schedules to setup and control the data ingest, processing, storage, and distribution functions. During post-pass processing, IDPS receives rate buffered, prioritized CADUs from C3S. IDPS ingests the data and returns a Receipt Report to C3S for comparison against data transmission records to check for data loss during the transfer. Ancillary data are received by the Ingest Data function, validated, and along with the RDRs, stored locally and for subsequent processing into SDRs and EDRs.

Stored RDRs are retrieved from storage and used by the Process Data Records function to generate SDRs and EDRs. The SDRs and EDRs are placed in temporary storage for subsequent retrieval by the Format and Distribute Data function. The data are then formatted per the earlier product subscription specification from the Centrals and SDS. The Manage IDPS function subsequently sends distribution control information to the Format and Distribute Data function to forward stored data (containing SDRs, EDRs, or RDRs) to the Centrals and to send RDRs to SDS. At the Centrals and SDS the Data are ingested and made available for further processing.

4.2.3.6 Operational Processing (SDR and EDR Generation)

Objective:

This scenario (Figure 4-6) depicts the processing, storage, ordering, and shipment of ATMS, CrIS, and VIIRS science data records and environmental data records in greater detail than the previous scenario. It also shows the sequencing of interaction between IDPS the Archive and Distribution Segment

Assumptions:

- Users have access to the inventory of products available in NPP's archive.
- Stored Ancillary Data, Digital Elevation Model (DEM) mask maps, and Surface emissivity maps have been received from the Ancillary Data systems and are available on IDPS storage area
- Raw data records (RDRs) and applicable processing calibration coefficients are available for processing

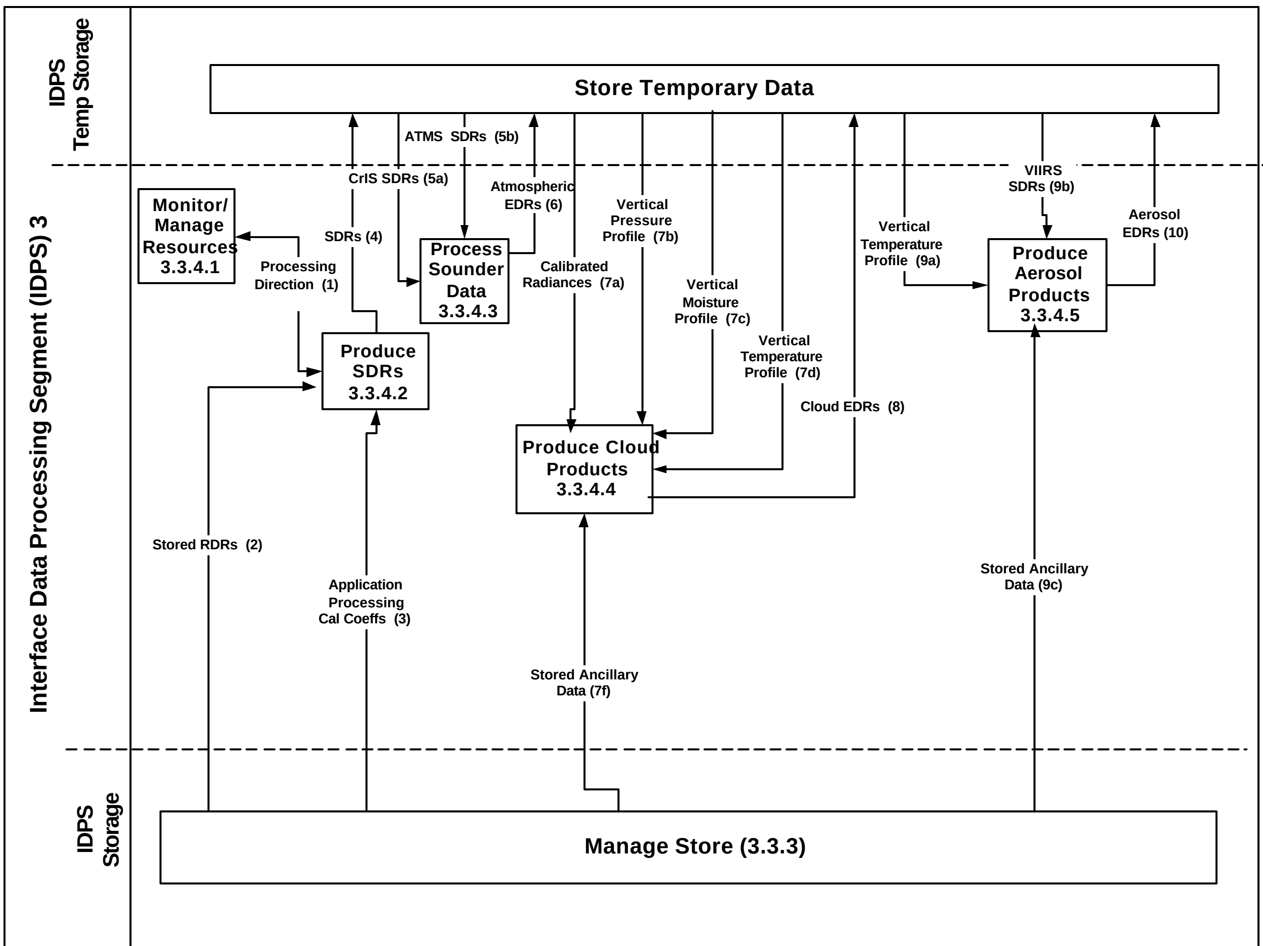

Figure 4-6 Operational Processing (SDR & EDR Generation) Scenario 4.2.3.6 (1 of 2)

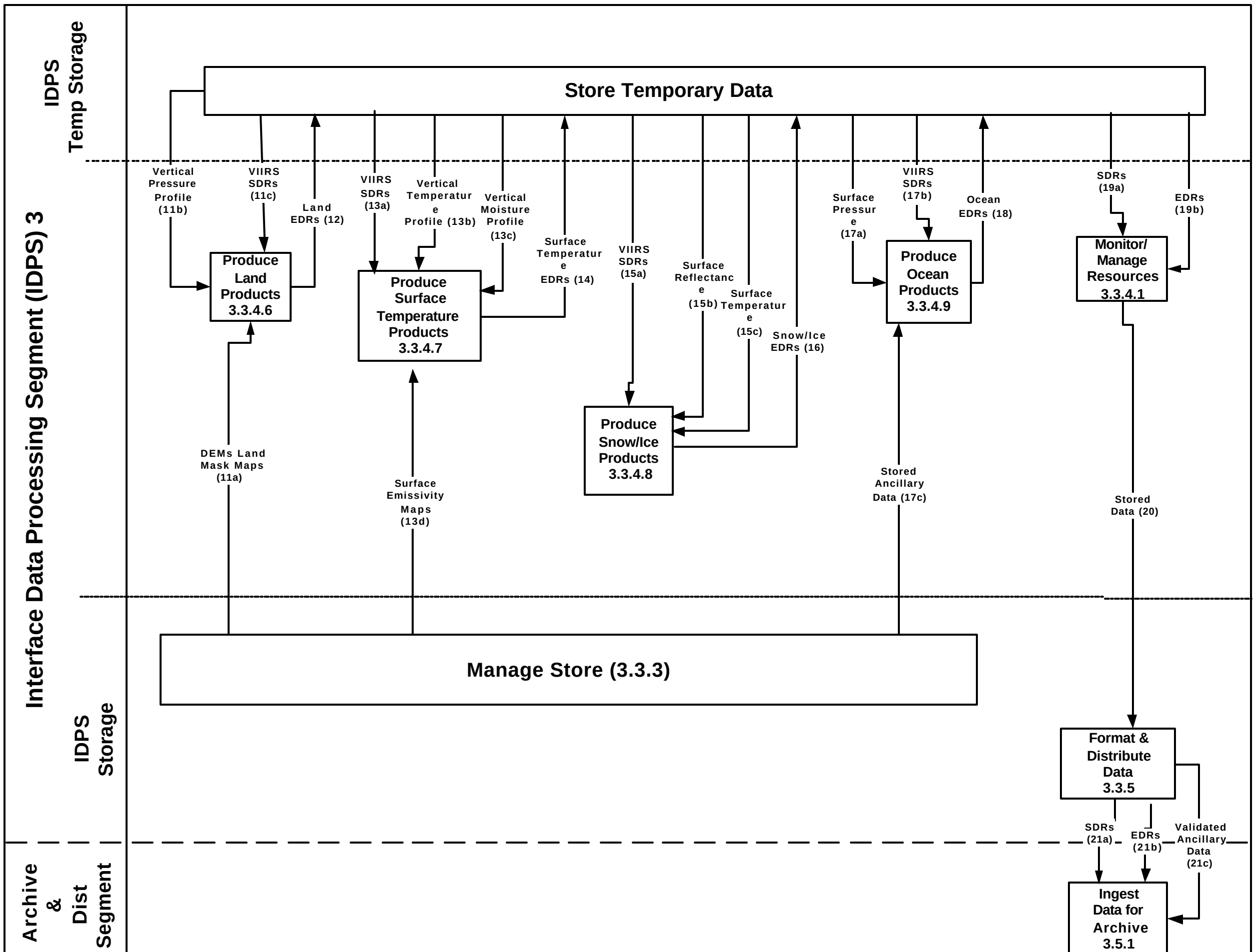

Figure 4-6 Operational Processing (SDR & EDR Generation) Scenario 4.2.3.6 (2 of 2)

Scenario Description:

Figure 4.2.3.6 depicts the Operational Processing Sensor Data Record and Environmental Data Record generation scenario.

The Monitor/Manage Resources function provides processing direction to the Produce SDRs function. Using that guidance, the Produce SDR function retrieves stored RDRs, application processing cal coefficients, and stored ancillary data and then produces SDRs (VIIRS, CrIS, and ATMS) which are then placed in temporary storage.

Subsequently, the various SDRs are retrieved for processing into environmental data records (EDRs) types that include the following:

- Sounder Data
- Cloud Products
- Aerosol Products
- Land Products
- Surface Temperature Products
- Snow/Ice Products

– Ocean Products

Stored Ancillary Data may be used for processing the associated EDRs. In addition, Land Products will require Digital Elevation Model (DEM) mask maps and Surface Temperature Products will require surface emissivity maps.

Note 1: Once the SDRs are in temporary storage, the order of EDR processing is independent and may even take place in parallel since neither function receives input from the others.

Note 2: The sequence numbers contained in the EDR generation scenario are only used as a sequential processing example.

<u>Sounder Data</u>

The Process Sounder data function retrieves CrIS and ATMS SDRs from the temporary data store and converts them into Atmospheric EDRs which are forwarded to the temporary store.

<u>Cloud Products</u>

Cloud EDRs are generated in the Produce Cloud Product function by ingesting calibrated radiances, vertical pressure profiles, vertical moisture profiles, vertical temperature profiles from the temporary store and Stored Ancillary Data from the Manage Store function.

<u>Aerosol Products</u>

The production of aerosol products involves the retrieval of VIIRS SDRs and vertical temperature profiles from temporary storage and Stored Ancillary Data from the Manage Store function. The resulting aerosol EDRs are stored in the temporary store.

<u>Land Products</u>

The Produce Land Products function uses vertical pressure profiles, VIIRS SDRs, DEM land mask maps and CMIS type data to generate land EDRs.

<u>Surface Temperature Products</u>

VIIRS SDRs, vertical temperature profiles, vertical moisture profiles, surface emissivity maps, and CMIS type data are sent to the Produce Surface Temperature function to generate surface temperature EDRs.

<u>Snow/Ice Products</u>

Snow/Ice EDRs are generated by the Produce Snow/Ice Products function using VIIRS SDRs, surface reflectance, and surface temperature.

Ocean Products

The Produce Ocean Products function generates Ocean EDRs by processing VIIRS SDRs, surface pressure, and Stored Ancillary Data.

At step 19a and 19b, the EDRs, SDRs, and RDRs, in the form of stored data, are pulled from temporary storage by the Monitor/Manage Resources function and transferred to the Format and Distribute Data function. There, the data is validated and passed to the Ingest Data for Archive function in the Archive and Distribution Segment.

4.2.3.7 Receiving, Processing, and Archiving of Climate Data

Objective:

The objective of this scenario (Figure 4-7) is to identify the steps for receiving, processing, and archiving the climate data. This sequence of steps provides for the transfer of the RDRs from the IDPS to the SDS, the processing to level 1B data products and the processing to higher-level climate products within the SDS.

Assumptions:

- The SDS has submitted a product subscription to the IDPS to receive all processed RDRs.
- Science calibration coefficients to be used in the Climate Data processing are available from the SDS calibration functions.

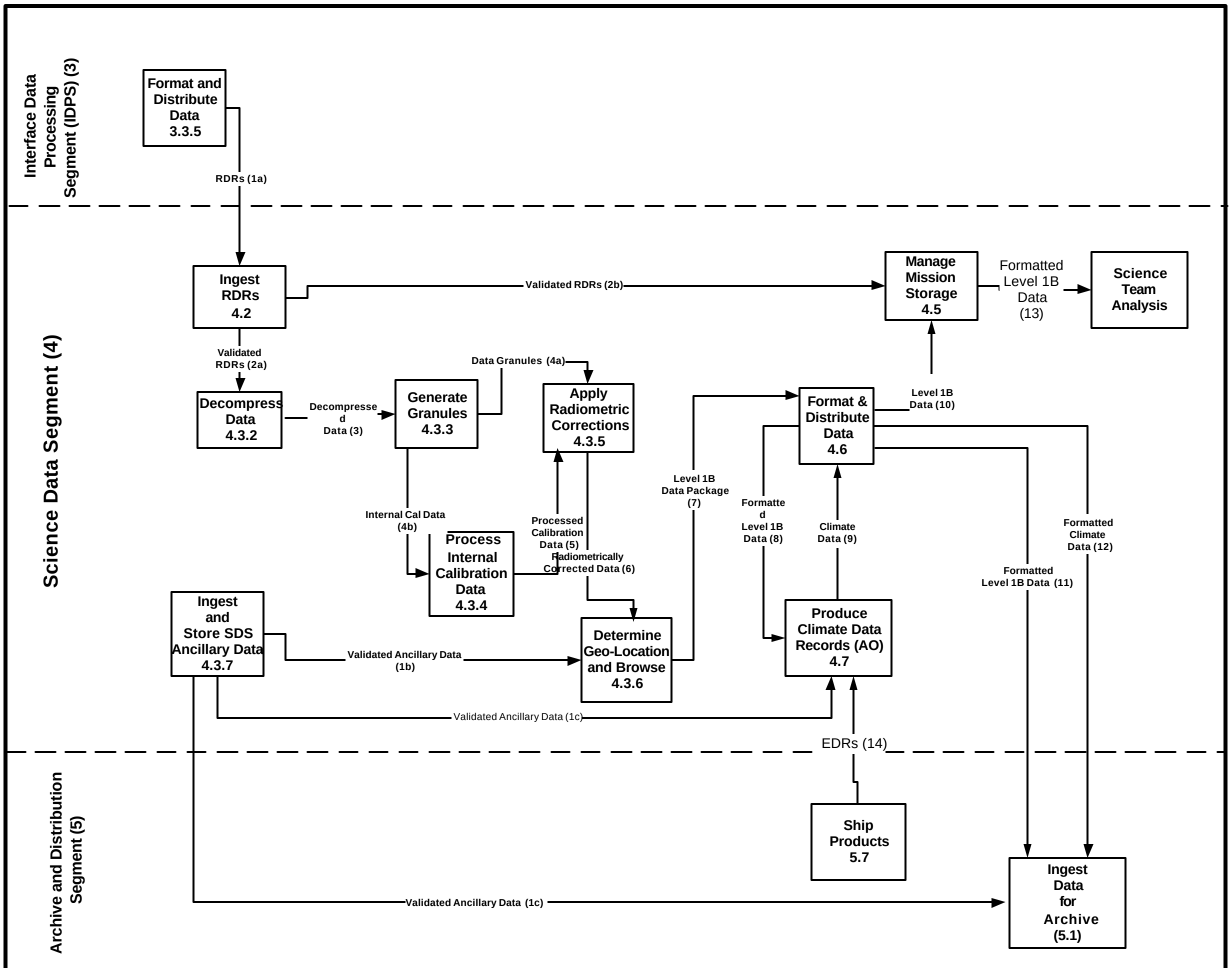

Figure 4-7 Receiving, Processing, and Archiving of Climate Data Scenario 4.2.3.7

Scenario Description:

Prior to receiving the data from the IDPS, the SDS ingests the ancillary data needed to perform the climate processing. After the IDPS completes processing the raw data to RDRs, it forwards the data to the SDS for climate data processing. The RDRs are validated for form and fit. The data are decompressed and reformatted as necessary to facilitate additional processing. The internal data, or on-board generated calibration data, are processed. Radiometric corrections are applied to the RDRs. Parameters for performing the radiometric correction are obtained from the Science Calibration Coefficient files or from the processed on-board calibration data. Data are geo-located and browse images are generated where applicable. The data are formatted as appropriate and forwarded for higher-level product generation and to the ADS for archive and distribution. The validated RDRs, as well as the Level 1B data, are forwarded to the mission storage. Upon completion of the higher-level processing, climate data are formatted and forwarded to the ADS for archive and distribution.

4.2.3.8 Calibration and Validation Processing

Objective:

The objective of this scenario is to identify the steps for performing the science calibration and validation processing. This sequence of steps provides for the transfer of the RDRs from the IDPS to the SDS, the processing of the calibration data to characterize the instruments, the generation/update of the science calibration parameters, as well as the determination for the need for a lunar calibration maneuver by the satellite.

Assumptions:

- The SDS has submitted a product subscription to the IDPS to receive all processed RDRs.
- The IDPS provides new Application Processing Cal Coefficients to the SDS when they are generated. These are expected to only occur periodically.

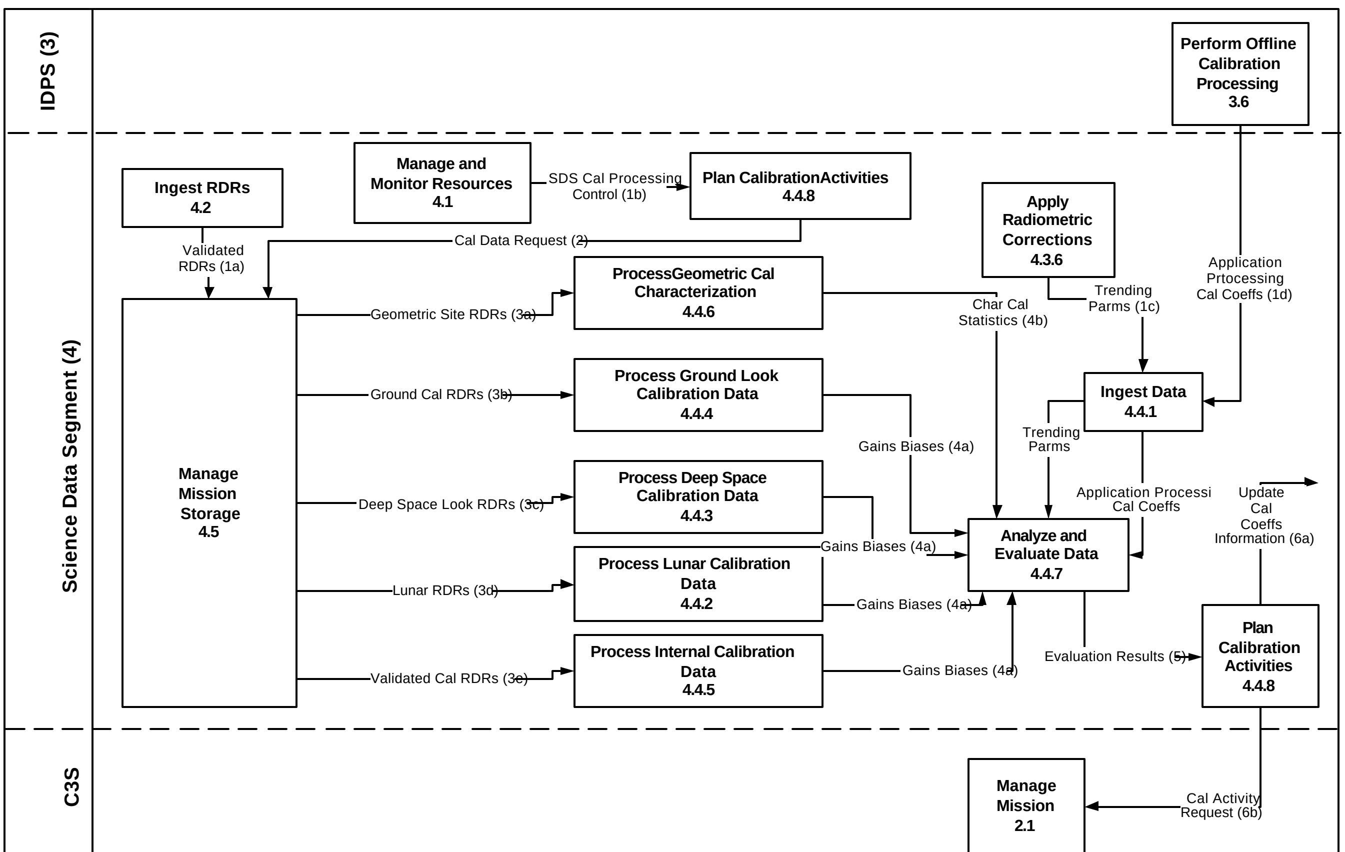

Figure 4-8a Calibration and Validation Processing 4.2.3.8 (1 of 2)

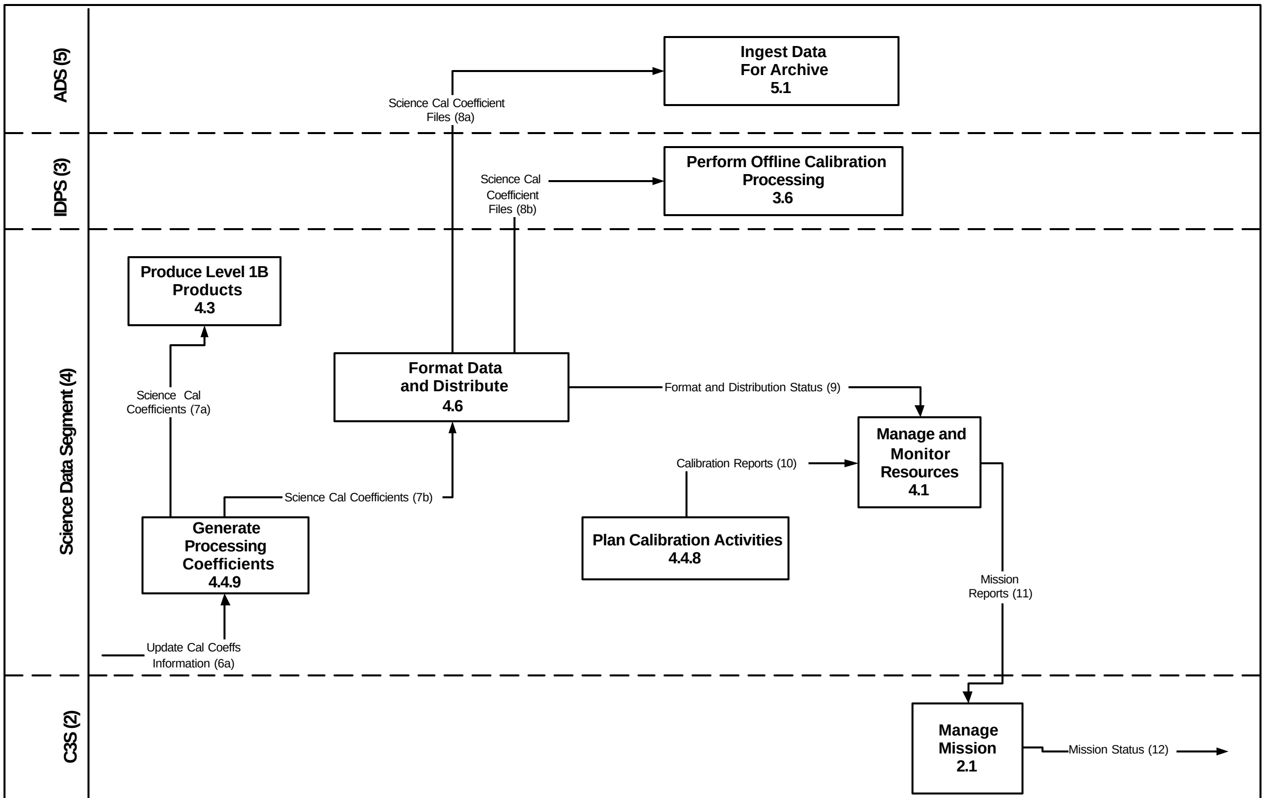

Figure 4-8b Calibration and Validation Processing 4.2.3.8 (2 of 2)

Scenario Description:

After the IDPS completes processing the raw data to RDRs, it forwards the RDRs to the SDS for climate data processing. The RDRs are validated for form and fit. The validated RDRs are provided to the SDS Mission Storage. Based upon the calibration processing control direction, calibration data are requested from the Mission Storage. Calibration RDRs are retrieved from the Mission Storage and provided to the appropriate Calibration and Validation processing function within the SDS. Note that Calibration RDRs can be forwarded to the appropriate calibration functions directly from the Ingest function if they are identified as calibration data within the science data downlink. Results of the radiometric and geometric characterizations are forwarded to the Analyze and Evaluate Data function. In addition to these results, trending parameters that are gathered from the production processing and the application processing calibration coefficients used in the IPDS production processing are used in the evaluation. If, based on the results of the analysis, an analyst determines that the coefficients used in the science production processing should be updated, update information is provided to the Generate Processing Coefficients function. The new coefficients are provided back to the science production processing functions as well as the Format and Distribute function for formatting and delivery to the IDPS and the ADS.

The analyst may also determine that some other calibration activity, such as a calibration maneuver or calibration deployment is needed to further characterize the instruments. In this case, a calibration activity request is provided to the Mission Management function within the C3S. The mission management function works with the satellite operations team to schedule the maneuver.

Calibration reports are generated by the calibration processing and provided to the Mission Management function. These reports contain information on the instrument characterization results as well as information on the current version of the science calibration coefficients. This information is made available as mission status to the NPP user communities.

4.2.3.9 Science Data Reprocessing

Objective:

The objective of this scenario (Figure 4-9) is to identify the steps for reprocessing the science data mission storage. It is not meant to show the steps for reprocessing an individual level 1B product. This sequence of steps provides for receiving the mission guidance to perform the reprocessing, actually performing the reprocessing, and providing reports back to the mission management on production status.

Assumptions:

- The NPP Mission Management, which includes the NPP Project Scientist, determines when the mission storage should be reprocessed. This determination is made based on recommendations from the Science Team.
- The new algorithms to be used in the processing have been made available and tested in the SDS environment.
- All data necessary to perform the reprocessing is available within the SDS
- Daily data processing must continue in parallel with the mission storage reprocessing.

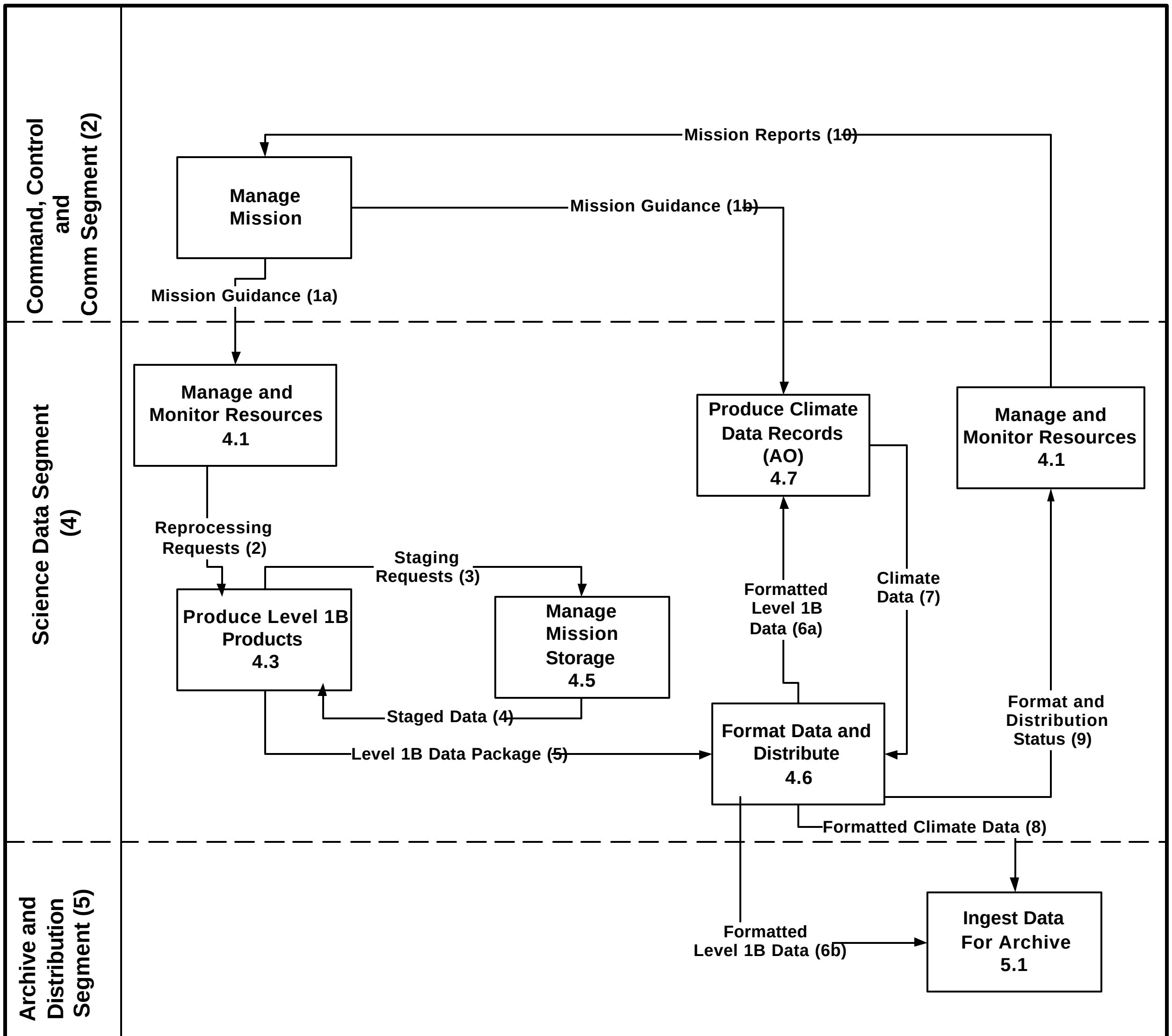

Figure 4-9 Science Data Reprocessing 4.2.3.9

Scenario Description:

The NPP Mission Management, based on recommendations from the science team and at the direction of the NPP Project Scientist, provides the SDS with direction to reprocess the data contained in the SDS mission storage. Based on available resources, data are staged on-line from the SDS mission storage. The RDRs are reprocessed to Level 1B products using the latest algorithms and/or calibration parameters. Detailed steps of this processing are provided in section 4.2.3.6. The data are formatted and provided to the climate data processing functions and to the ADS. The higher level processing functions reprocess climate data products as necessary and provide the formatted, new versions to the ADS for archive and distribution. The SDS gathers statistics on the reprocessing status and performance and generates reports for the mission management.

4.2.3.10 User Query, Order and Product Distribution

Objective:

The objective of this scenario (Figure 4-10) is to identify the steps for a user to interact with the archive and distribution segment. This sequence of steps provides for querying/searching the data holdings of the archive, submitting a user order for currently held data, and subsequently verifying the user's account and processing/preparing the product for delivery to the user.

Assumptions:

- User has a valid account or vehicle (i.e. credit card) which authorizes the user product request
- Database is populated with climate data and associated metadata
- Processing algorithm and calibration table information provided in conjunction with user product
- Pre-determined order options defined (media type, format, etc.); standard product billing defined

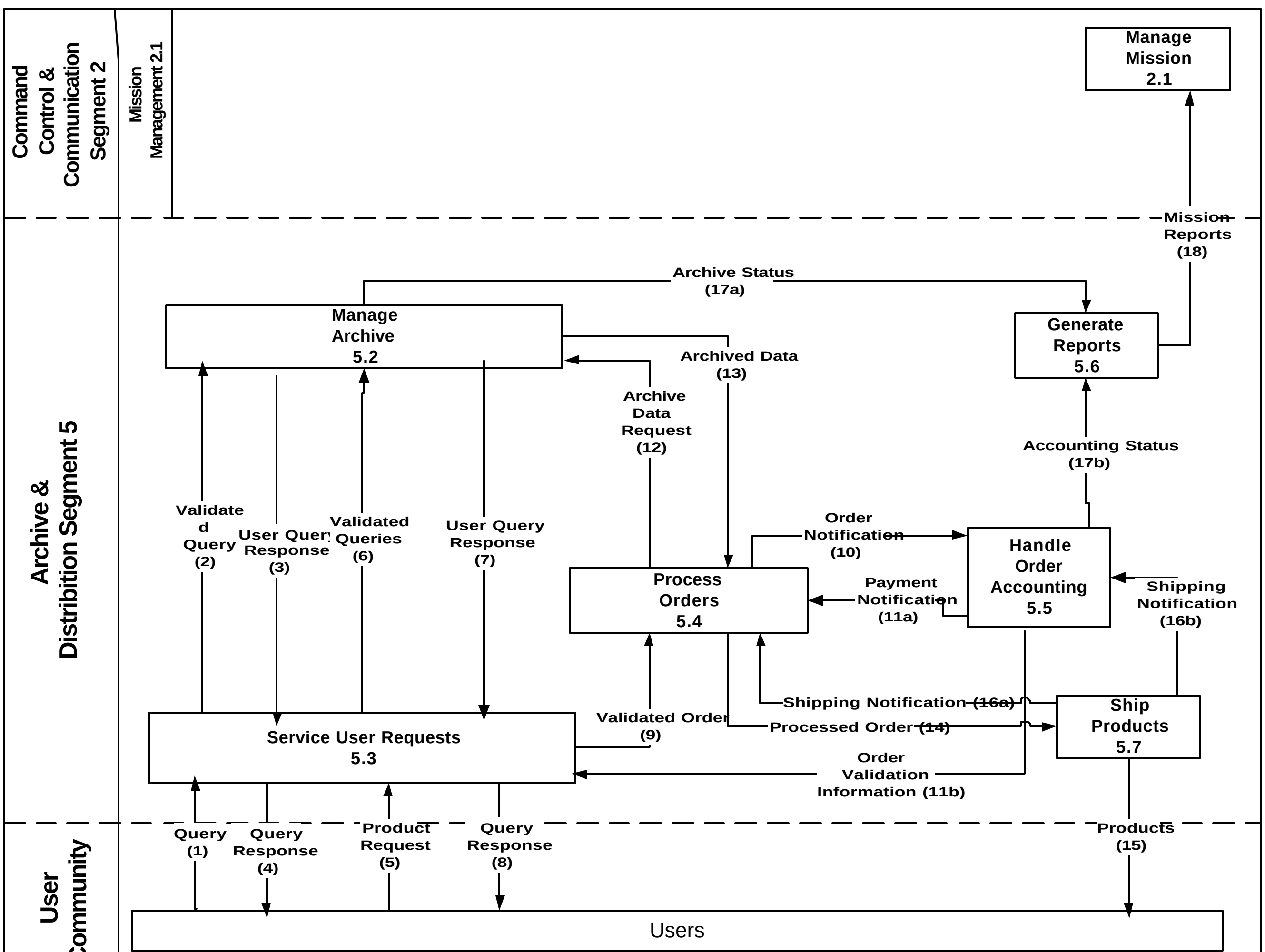

Figure 4-10 User Query, Order, and Product Distribution Scenario 4.2.3.10

Scenario Description:

A user initiates a query session via the archive and distribution segment's user interface soliciting information on data holdings for area/parameter of interest. Based on the user query, the inputs are validated and checked against the metadata associated with the archived data holdings. Responses to the user queries are returned to the user via the user interface within TBD seconds/minutes. Upon determination of desired product(s), the user submits a product request, again through the user interface. As with the queries, product requests are also validated and crossed checked with the data holdings. Additionally, the user account and/or payment method (i.e. credit card) is/are also validated. Payments for products are received (or valid standing accounts confirmed prior to processing the user request. Upon validation of the order and account or payment method, the appropriate archived data (telemetry and corresponding calibration data) are requested from the archive and provided to process/prepare the user-requested product. Following archive data extraction, status information for requested data is provided for reporting purposes. It is possible to have products fulfilled via a subscription order, so that upon data availability, products are automatically prepared and shipped without direct interaction with the system by the user. Once the order is generated, the product(s) is prepared for shipment to the user. The product(s) is then shipped to the user and shipping notification information is provided as status information for accounting and reporting purposes.

4.2.3.11 Calibration Maneuver Planning and Execution

Objective:

This scenario (Figure 4-11) explains the procedure for setting up and executing calibration maneuvers to obtain predetermined measurements from known space radiation sources for use in recalibrating onboard instruments. Periodically, the spacecraft will be commanded (via ground command) to reorient its attitude to take these measurements then return to its nominal configuration.

Assumptions:

- Offline analysis has shown a need for a calibration measurement
- The Space Network (SN) is required to assure uninterrupted communications during the maneuver
- Reorienting spacecraft antennae for SN communications is not required since it is expected that NPP will use Omni directional antennae.
- Spacecraft time is received continuously
- Maneuver planning coordination occurs between SDS, IDPS, and C3S.

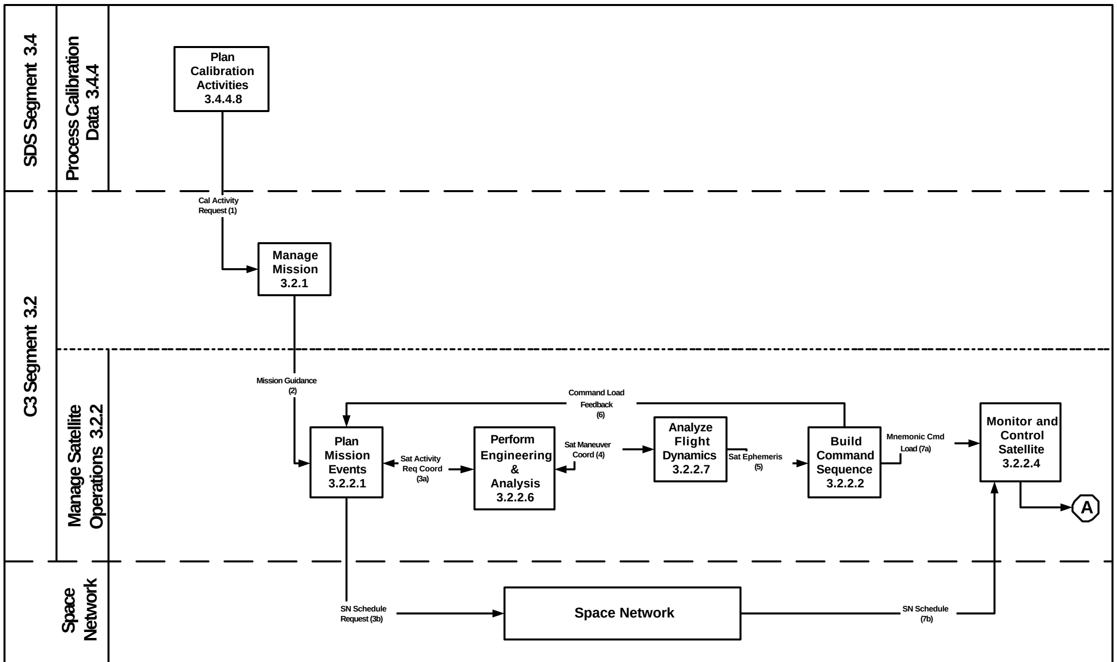

Figure 4-11a Calibration Maneuver Planning and Execution 4.2.3.11 (1 of 2)

Legend: (A) connects to Scenario 4.2.3.4.4

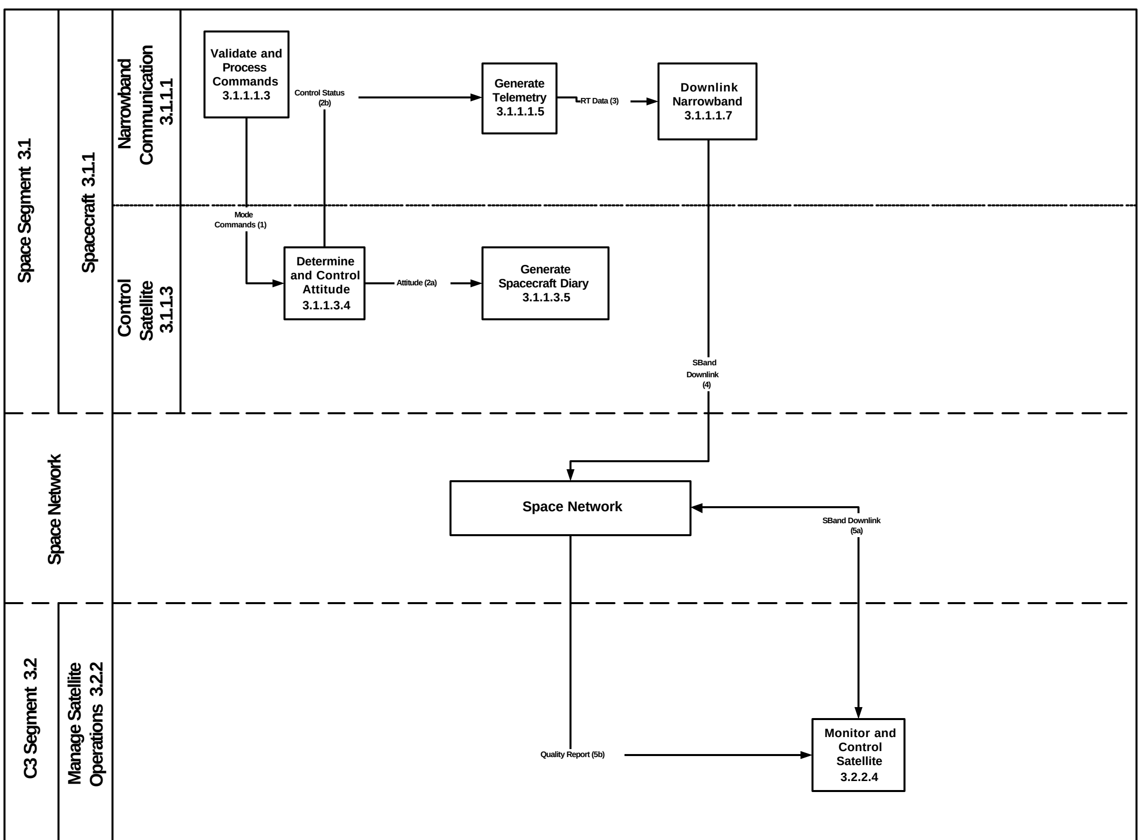

Figure 4-11b Calibration Maneuver Planning and Execution 4.2.3.11 (2 of 2)

Scenario Description:

Cal Maneuver planning is supported by the Plan Calibration Activities function within the SDS. The procedure starts when a Cal Activity Request requesting a calibration maneuver is forwarded from SDS to the Manage Mission function in C3S. After analysis and approval, mission guidance is sent to the Plan Mission Events function where the cal maneuver is scheduled.

Plan Mission Events coordinates satellite activity requests with the Perform Engineering and Analysis function in addition to making SN schedule requests with the Space Network. Satellite maneuver coordination is then performed between the Perform Mission Engineering function and the Analyze Flight Dynamics function. The resulting satellite ephemeris is then supplied to the Build Command Sequence function. The Build Command Sequence uses spacecraft ephemeris from the Flight Dynamics function along with command constraints from the Satellite Database to generate a mnemonic command load. The Build Command Sequence also provides command load feedback to Mission Planning. The Cal Maneuver commands are then uplinked as described in the Uplink Command Load Scenario (4.2.3.4.4).

Once the Cal Maneuver commands are received in the spacecraft's Narrowband Communication's Validate and Process Commands function, they are verified and passed on as mode commands changes to the Determine and Control Attitude function. The specified calibration maneuver is performed and feedback on the maneuver is provided in the form of control status that is sent to the Generate Telemetry function. In parallel, attitude readings are sent to the Generate Spacecraft Diary function.

The Generate Telemetry function packages the control status into RT data for transfer by the Downlink Narrowband function to the SN. The SN then transfers the Sband downlink to the Manage Satellite function within C3S. Here, the Monitor and Control Satellite receives the quality report for analysis of the maneuver.

4.2.3.12 Flight Software Update

Objective:

The objective of this scenario (Figure 4-12) is to a show time dependent flow of when and how the flight software is updated. Specifically, it shows the scenario for the update to ATMS, CrIS, and VIIRS software executables on-board the satellite.

Assumptions:

- Analysis has been done to indicate that there needs to be a change to the flight software.

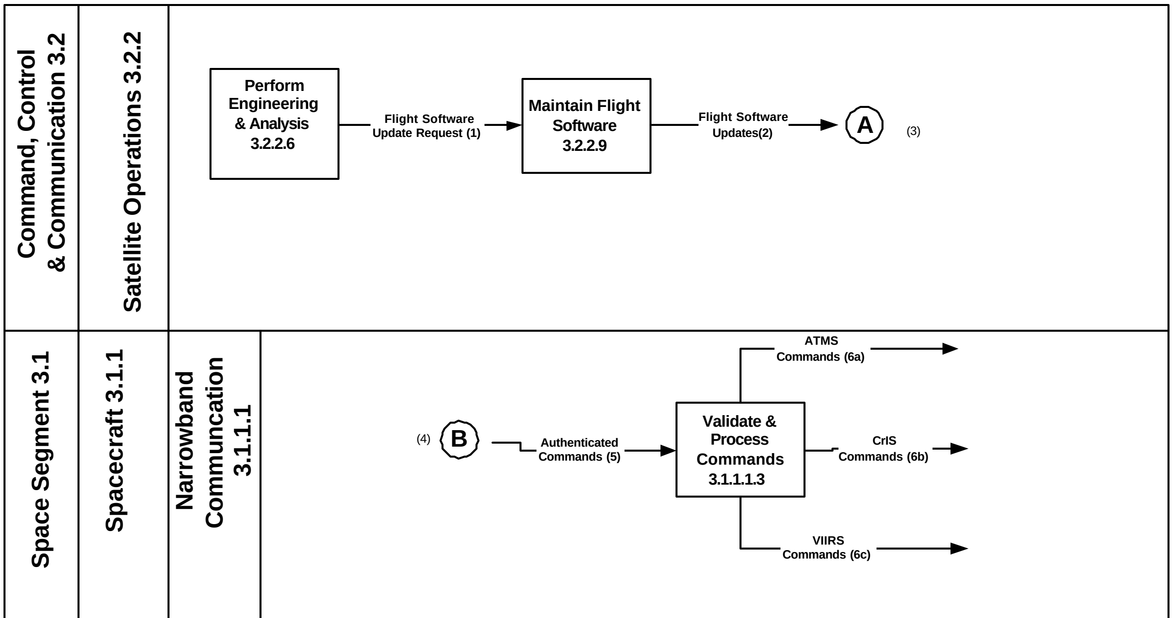

Figure 4-12 Flight Software Update Scenario 4.2.3.12 (1 of 2)

Legend:
(A) connects to Build Command Sequence 2.2.2 in the Build Satellite Schedules scenario

(B) connects to Authenticate Commands 1.1.1.2 in the Uplink Commands Load scenario

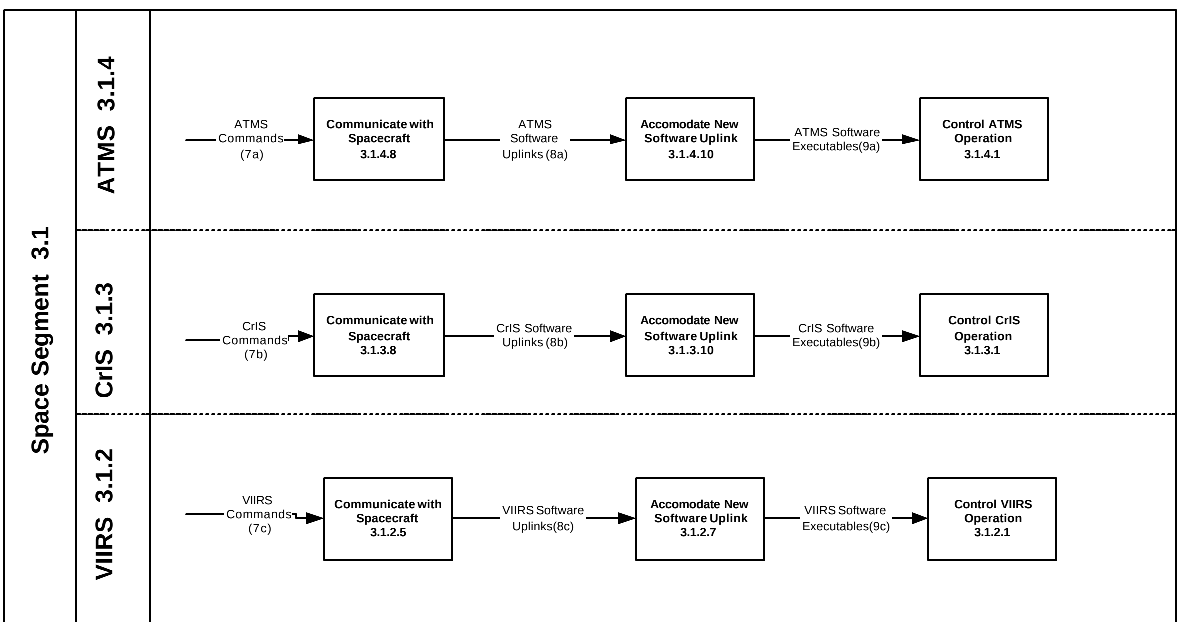

Figure 4-12 Flight Software Update Scenario 4.2.3.12 (2 of 2)

Scenario Description:

Upon analysis, the Satellite Operations functions decides on software updates. A decision for software updates causes the Perform Engineering and Analysis function to request software updates by the Maintain Flight Software function. Using the Uplink Command Load scenario, the updated software is then uplinked to the satellite.

The Validate and Process Commands function transfers the ATMS, CrIS and VIIRS commands to the associated Communicate with Spacecraft functions within the instruments.

The ATMS, CrIS and VIIRS software uplinks are sent to the associated Accommodate New Software Uplink functions. Within the associated Accommodate New Software Uplink functions, the executables are generated and sent to the associated Control Operation instrument functions.

4.2.4 Non-Nominal Operations

The non-nominal operations mode includes those satellite or data handling activities necessary to address any out-of-the-ordinary mission situation. While some anomalous conditions can be anticipated, expansion of the operations planning for such is expected during the remainder of the mission formulation phase and throughout the implementation thereby being responsive to the architecture/design. Thus, only a small set of non-nominal scenarios are included here.

4.2.4.1 Safehold/Autonomous Failsafe Occurrence and Recovery

Objective:

This scenario (Figure 4-13) illustrates the autonomous reaction of the spacecraft failsafe protection function to a failure occurrence and subsequent recovery through ground recognition and response.

Assumptions:

- None

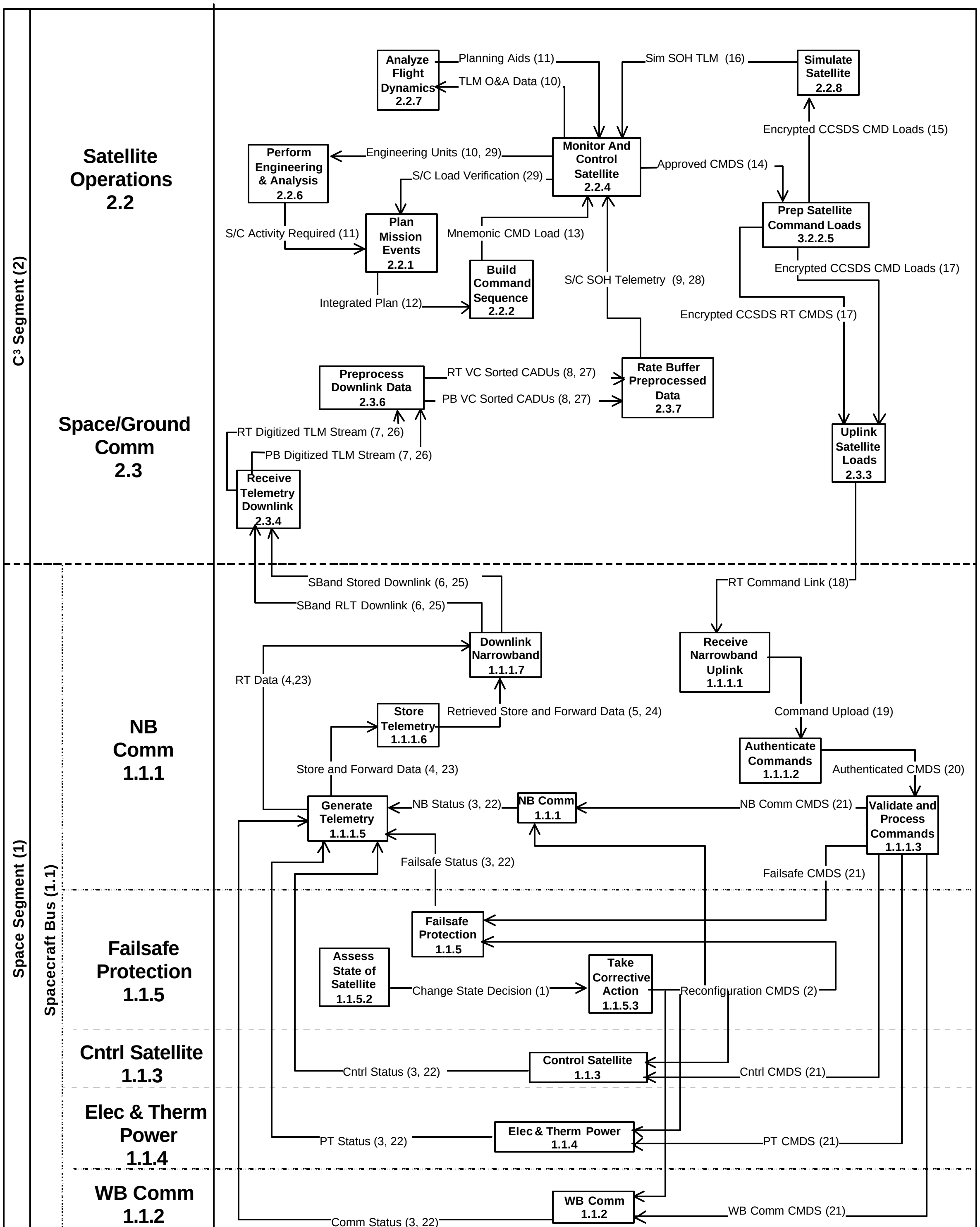

Figure 4-13 Safehold/ Autonomous Failsafe Occurrence and Recovery

Scenario Description:

The spacecraft failsafe protection recognizes a failure situation and initiates protection by commanding the satellite into a safe state. To accomplish this the Assess State of Satellite 1.1.5.2 function sends a Change State Decision (1) to the Take Corrective Action 1.1.5.3 function. Following the Change State Decision (1), the Take Corrective Action 1.1.5.3 function sends Reconfiguration Commands (2) to spacecraft functions to safe the spacecraft.

The spacecraft telemetry changes to reflect the reconfigured spacecraft status. All spacecraft functions continuously send status (3) to the NB Comm Generate Telemetry 1.1.1.5 function.

Spacecraft telemetry is both stored for direct station playback and sent in realtime. The Generate Telemetry 1.1.1.5 function sends Store and Forward Data (4) to the Store and Forward Telemetry 1.1.1.6 function. Simultaneously, the Generate Telemetry 1.1.1.5 function sends RT Data (4) to the Downlink Narrowband1.1.1.7 function.

The spacecraft telemetry is then downlinked to engineers in the mission operations control center. The Store Telemetry function 1.1.1.6 function sends Retrieved Store and Forward Data (5) to the Downlink Narrowband 1.1.1.7 function. The Downlink Narrowband 1.1.1.7 function sends SBand RLT Downlink (6) and SBand Stored Downlink (6) to the Receive Telemetry Downlink 2.3.4 function.

The downlinked spacecraft telemetry is processed through the receiving station, through initial ingest functions, and formatted for spacecraft engineers' analysis. The Receive Telemetry Downlink 2.3.4 function sends RT Digitized TLM Stream (7) and PB Digitized TLM Stream (7) to the Preprocess Downlink Data 2.3.6 function. The Preprocess Downlink Data 2.3.6 function sends RT VC Sorted CADUs (8) and PB VC Sorted CADUs (8) to the Rate Buffer Preprocessed Data 2.3.7 function. The Rate Buffer Preprocessed Data 2.3.7 function sends S/C SOH Telemetry (9) to the Monitor And Control Satellite 2.2.4 function. The Monitor And Control Satellite 2.2.4 function sends Engineering Units (10) to the Perform Engineering & Analysis 2.2.6 function. The Monitor And Control Satellite 2.2.4 function sends TLM O&A Data (10) to the Analyze Flight Dynamics 2.2.7 function.

Engineers evaluate the spacecraft status and generate required spacecraft activity to restore the spacecraft to normal operation. The Analyze Flight Dynamics 2.2.7 function sends Planning Aids (11) to the Monitor And Control Satellite 2.2.4 function. The Perform Engineering & Analysis 2.2.6 function sends S/C Activity Required (11) to the Plan Mission Events 2.2.1 function. The Plan Mission Events 2.2.1 function sends an Integrated Plan (12) to the Build Command Sequence 2.2.2 function. The Build Command Sequence 2.2.2 function sends a Mnemonic CMD Load (13) to the Monitor And Control Satellite 2.2.4 function. The Monitor And Control Satellite 2.2.4 function sends Approved CMDS (14) to the Prep Satellite Command Loads 3.2.2.5 function.

During preparation, command loads may be tested through the satellite simulator. The Prep Satellite Command Loads 3.2.2.5 function sends Encrypted CCSDS CMD Loads (15) to the Simulate Satellite 2.2.8 function. The Simulate Satellite 2.2.8 function sends Simulated SOH TLM (16) to the Monitor And Control Satellite 2.2.4 function.

Validated realtime commands and command loads are uplinked to the spacecraft. The Prep Satellite Command Loads 3.2.2.5 function sends Encrypted CCSDS RT CMDS (17) to the Uplink Satellite Loads 2.3.3 function. The Prep Satellite Command Loads 3.2.2.5 function sends Encrypted CCSDS CMD Loads (17) to the Uplink Satellite Loads 2.3.3 function. The Uplink Satellite Loads 2.3.3 function sends the RT Command Link (18) to the Receive Narrowband Uplink1.1.1.1 function.

The received command load is authenticated, validated, processed, and executed. The Receive Narrowband Uplink 1.1.1.1 function sends the Command Upload (19) to the Authenticate Commands 1.1.1.2 function. The Authenticate Commands 1.1.1.2 function sends Authenticated CMDS (20) to the Validate and Process Commands 1.1.1.3 function. The Validate and Process Commands 1.1.1.3 function sends CMDS (21) to all required spacecraft functions.

When the desired changes have been made to the spacecraft, the spacecraft telemetry changes in response to the ground commands. All spacecraft functions continuously send Status (22) to the Generate Telemetry 1.1.1.5 function.

The spacecraft telemetry is again stored for direct station playback and sent in realtime. The Generate Telemetry 1.1.1.5 function sends Store and Forward Data (4) to the Store and Forward Telemetry 1.1.1.6 function. Simultaneously, the Generate Telemetry 1.1.1.5 function sends RT Data (4) to the Downlink Narrowband1.1.1.7 function.

The spacecraft telemetry is again downlinked to engineers in the mission operations control center for further evaluation. The Store Telemetry function 1.1.1.6 function sends Retrieved Store and Forward Data (5) to the Downlink Narrowband 1.1.1.7 function. The Downlink Narrowband 1.1.1.7 function sends SBand RLT Downlink (6) and SBand Stored Downlink (6) to the Receive Telemetry Downlink 2.3.4 function.

As before, the downlinked spacecraft telemetry is processed through the receiving station, through initial ingest functions, and formatted for spacecraft engineers' analysis. The Receive Telemetry Downlink 2.3.4 function sends RT Digitized TLM Stream (7) and PB Digitized TLM Stream (7) to the Preprocess Downlink Data 2.3.6 function. The Preprocess Downlink Data 2.3.6 function sends RT VC Sorted CADUs (8) and PB VC Sorted CADUs (8) to the Rate Buffer Preprocessed Data 2.3.7 function. The Rate Buffer Preprocessed Data 2.3.7 function sends S/C SOH Telemetry (9) to the Monitor And Control Satellite 2.2.4 function. The Monitor And Control Satellite 2.2.4 function sends Engineering Units (10) to the Perform Engineering & Analysis 2.2.6 function. The Monitor And Control Satellite 2.2.4 function sends TLM O&A Data (10) to the Analyze Flight Dynamics 2.2.7 function.

Spacecraft engineers evaluate spacecraft telemetry and confirm spacecraft recovery.

4.2.4.2 Anomaly Detection/Reaction (non-autonomous)

Objective:

The objective of this scenario (Figure 4-14) is to describe the steps necessary to react to a data anomaly, which ultimately results in the need to update the science processing calibration coefficients. The data flows for error handling have been, for the most part, omitted from the DFDs shown in Section 3 in order to minimize their complexity. Inter- and intra-segment anomaly resolution coordination is implied. Thus, the scenario description and the scenario diagram are representative of the actions taken even though they not appear directly in the DFDs.

Assumptions:

- NPP mission is functioning in the nominal operations mode
- routine satellite and data operations are in progress; data records / products are being provided to and archived within the ADS
- global change community members are requesting and receiving data from the ADS for climate analyses.

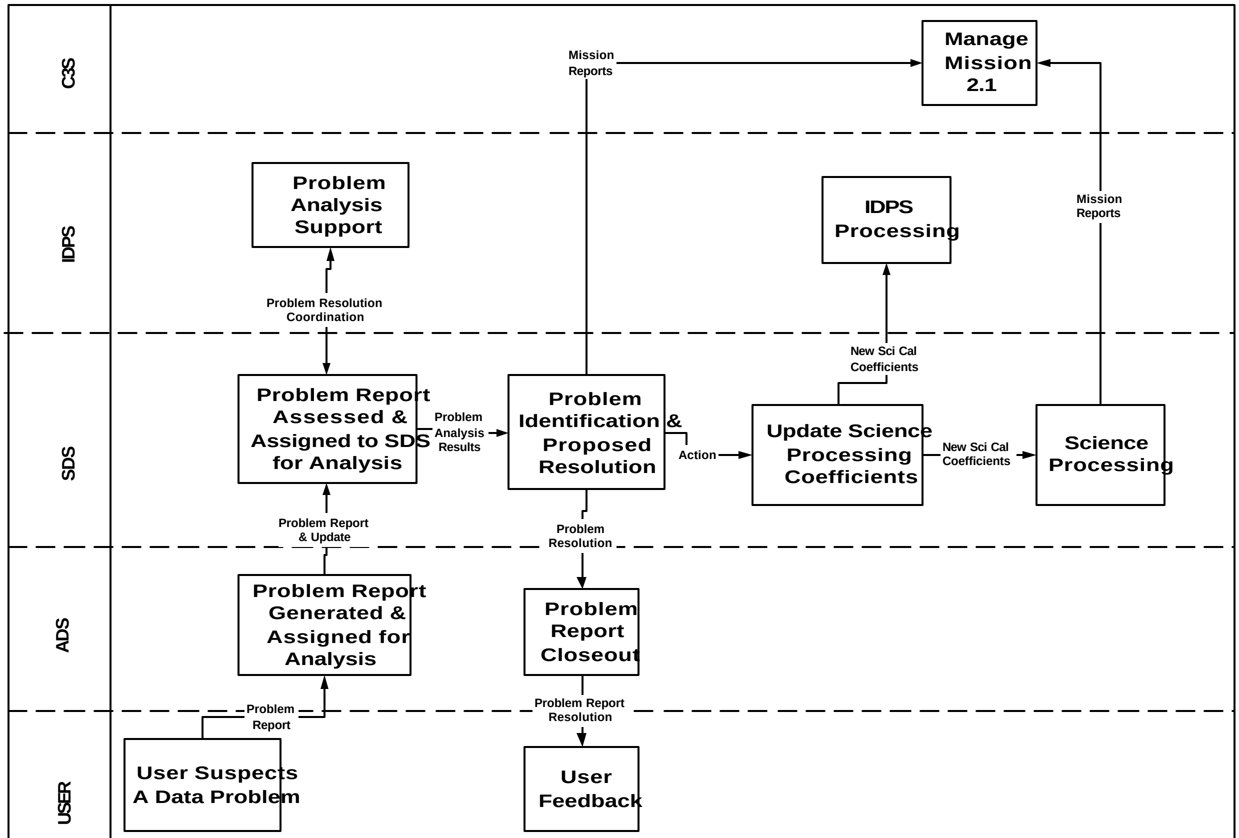

Figure 4-14 Anomaly Detection/Reaction (non-autonomous) 4.2.4.2

Scenario Description:

A user of the global change community requested data from the ADS. Upon using the requested data for climate studies, the user encountered a questionable data product. The user contacted the direct supplier of the data, the ADS, to report a potential data problem, possibly a band off-set condition with the VIIRS data. As the first line of problem resolution, the problem is logged and assigned for analysis. The ADS staff analyzes the data held in the archive and associated software to determine whether system processing was compromised. With no evidence of ADS problems, the ADS

Relays the data anomaly to the SDS which was responsible for the generation of the VIIRS data product and its submission to the ADS for archival purposes.

The SDS analyzes the VIIRS product, the processing steps, the raw data, and the calibration files. Additionally, the instrument trending data are also assessed. Upon completion of the analyses, it is determined that due to instrument degradation, an update to the science processing calibration file is warranted. The SDS evaluates and tests suggested changes to the calibration file. Once assured that changes properly addresses the problem, the SDS conveys the findings and the updated Science Cal Coefficients File to the IDPS for consideration of possible changes to the Application Processing Cal Coefficients.

Coordination between the IDPS and the SDS occurs as soon as it is suspected that the problem may be related to a calibration file problem. Additionally, the Mission Management function is also informed of the problem as reported and is part of the coordination process. The analysis results are provided to the Mission Management for tracking and information purposes via Mission Reports. Collectively, the IDPS and SDS may recommend that an update to the instrument calibration table be made on-board the satellite. The originator the problem, the user, is provided with feedback as to the problem identification and the corrective action being taken.

4.2.4.3 Retransmission from Polar Ground Station

Objective:

The objective of this scenario (Figure 4-15) is to accomplish a retransmission of SMD data, in the form of Prioritized CADUs, from a polar ground station capture site and route it to the IDPS.

Assumptions:

- the IDPS has received the WB Downlink Schedule and has completed ingesting data from a polar ground station contact (initial receipt)
- the IDPS has generated Ingest Control information, including actual data receipt information
- the polar ground stations has retained the SMD downlinked data in the CADU temporary store

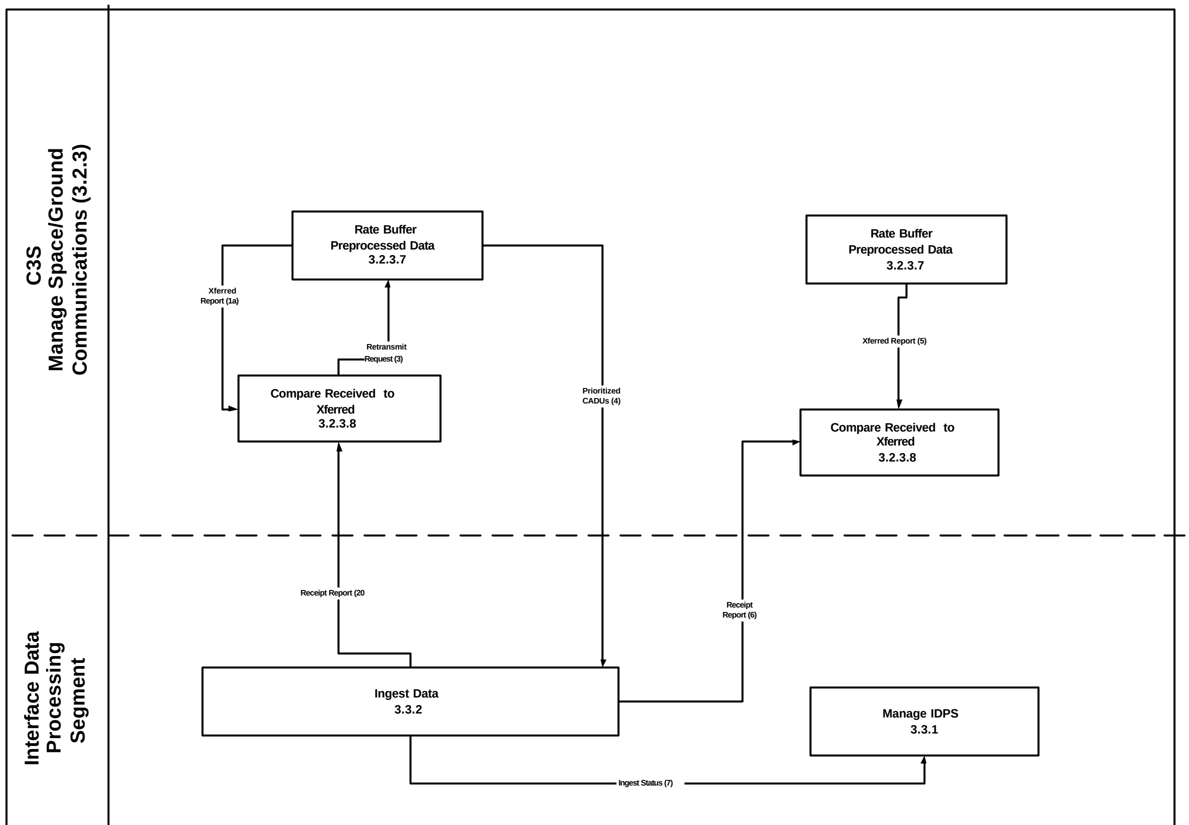

Figure 4-15 Retransmission From Polar Ground Station Scenario 4.2.4.3

Scenario Description:

The IDPS, having already ingested data from a polar ground station contact, generates a Receipt Report which is provided to the C3S Compare Received to Xferred function to compare the data received by the IDPS to data sent by the C3S. Upon comparison, it is determined that the IDPS did not received all data sent. A Retransmit Request is generated and forwarded to the Rate Buffer Preprocess Data function to request data, temporarily held at the capture site, be retransmitted. The Prioritized CADUs are resent, following coordination between the IDPS and C3S to schedule the retransmission.

Upon receipt of the Prioritized CADUs, the Ingest Data function receives the retransmitted data, and provides Ingest Status information to the Manage IDPS function. Again, the Receipt Report is provided to the Compare Received to Xferred function to compare to the report identifying actual data sent. Based on the retransmission, the complete set of the downlinked data is verified has having been received. Mission Reports, as routinely done, are provided from the IDPS to the C3S Mission Management function.

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Appendix A

Acronyms and Abbreviations

ADS	Archive and Distribution Segment	CH-02
AO	Announcement of Opportunity	CH-02
APS	Application Processing System	
ATMS	Advanced Technology Microwave Sounder	
C3S	Command, Control and Communications Segment	
CADUs	Channel Access Data Units	
CCSDS	Consultative Committee on Space Data Systems	
COFR	Cost of Fulfilling a User Request	CH-02
Conops	NPP System and Operations Concept	
CrIS	Cross-Track Infrared Sounder	
DFDs	Data Flow Diagrams	CH-02
EDRs	Environmental Data Records	
ELV	Expendable Launch Vehicle	
EOS	Earth Observing System	
EOS Aqua	EOS Aqua Spacecraft	
EOS Terra	EOS Terra Spacecraft	CH-02
FNMOC	Fleet Numerical Meteorology and Oceanography Center	
FOV	Field of View	
GPS	Global Positioning System	
GSE	Ground Support Equipment	
GSFC	Goddard Space Flight Center	
HRD	High Rate Data	
IDIQ	Indefinite Delivery/Indefinite Quantity	
IDPS	Interface Data Processing Segment	
IIA	Initial Implementation Agreement	
IOO	Instrument of Opportunity	
IORD	Integrated Operational Requirements Document	
IPF	Integrated Processing Facility	
IPO	Integrated Program Office	
Kbps	kilobits per second	
km	kilometer	
KSC	Kennedy Space Center	
LRD	Low Rate Data	
LSS	Launch Service Segment	
LSSP	Launch Site Support Plan	
LV	Launch Vehicle	
		CH-02

MDC	Mission Director Center
MSPSP	Missile System Pre-launch Safety Package
	CH-02
NASA	National Aeronautics and Space Agency
NAVOCEANO	Naval Oceanographic Office
NESDIS	National Environmental Satellite, Data, and Information Service
NLS	NASA Launch Services
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
	CH-02
Pkts	Packets
PPF	Payload Processing Facility
PRD	Program Requirement Document
PT	Power and Thermal
QA	Quality Assurance
RDRs	Raw Data Records
RF	Radio Frequency
RLCC	Remote Launch Control Center
RT	Realtime
SC	Spacecraft
SDRs	Sensor Data Records
SDS	Science Data Segment
SMD	Stored Mission Data
SN	Space Network
SOH	State-of-Health
SRD	Sensor Requirements Document
SS	Space Segment
	CH-02
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
USAF	United States Air Force
VAFB	Vandenberg Air Force Base
VC	Virtual Channel
VIIRS	Visible-Infrared Imager Radiometer Suite
WB	Wideband
WR	Western Range